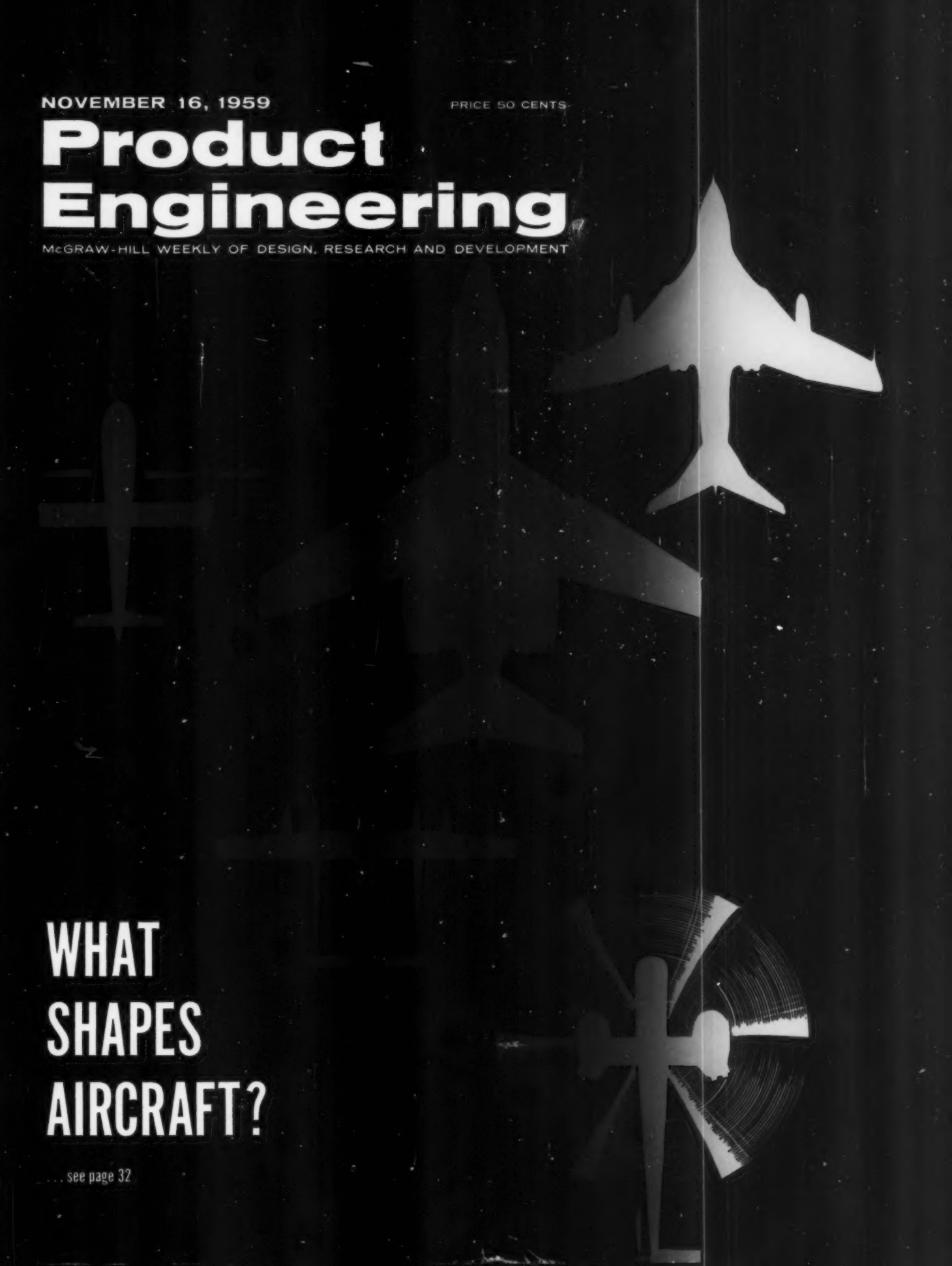
NOVEMBER 16, 1959

PRICE 50 CENTS

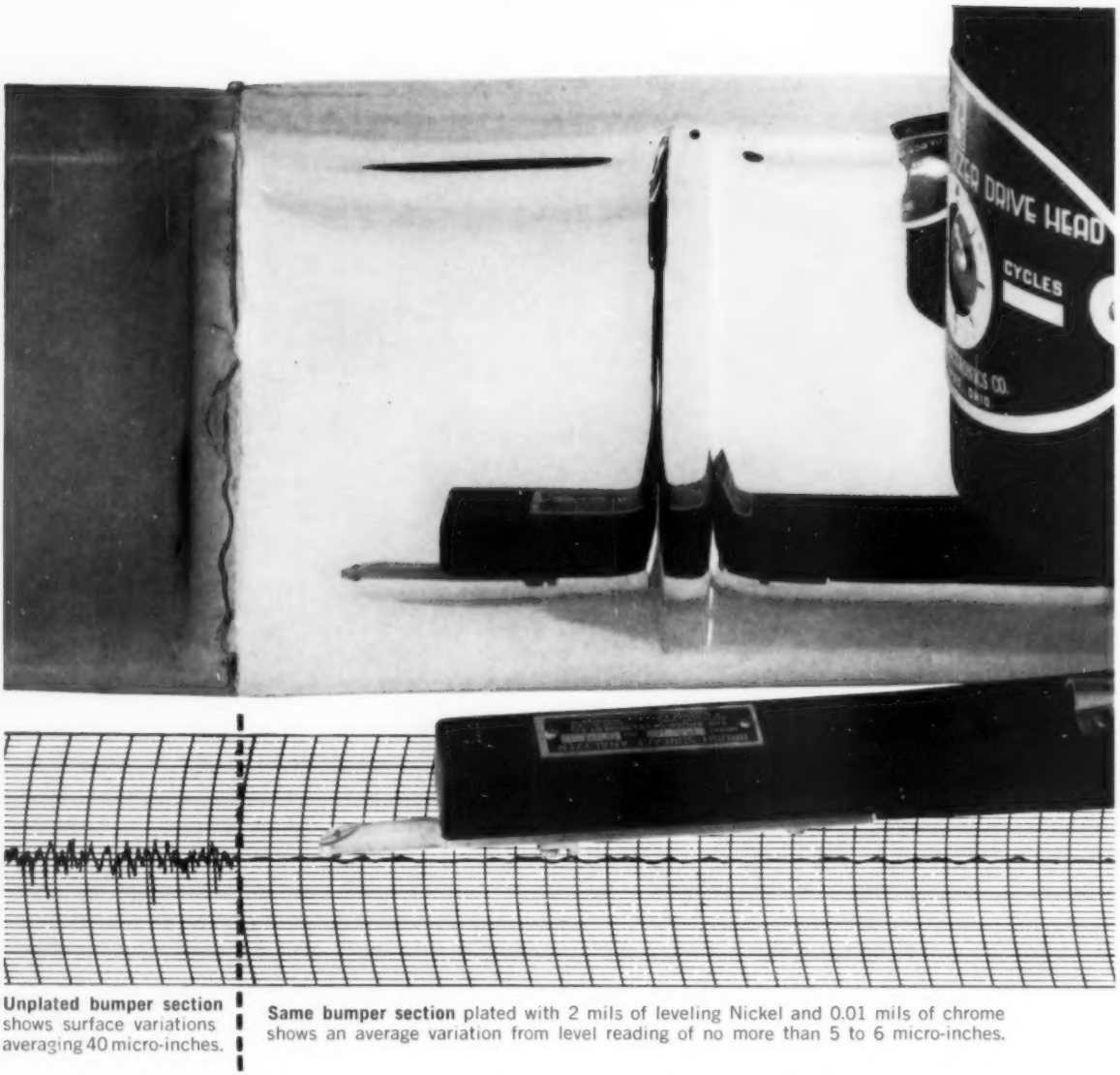
Product Engineering

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT



WHAT SHAPES AIRCRAFT?

... see page 32



Unplated bumper section shows surface variations averaging 40 micro-inches.

Same bumper section plated with 2 mils of leveling Nickel and 0.01 mils of chrome shows an average variation from level reading of no more than 5 to 6 micro-inches.

See how a layer of leveling Nickel takes polishing-buffing costs out of plating

Above, you see how a layer of leveling Nickel can be used on bare steel to even out surface imperfections, reducing the need for polishing and buffing before and after plating.

The leveling Nickel, however, could have been applied to a zinc, brass or aluminum part or product with equally good results

Special Nickel baths have been developed to coat and smooth the rough surfaces of a wide range of basis metals. By employing these baths, engineers and designers can reduce, in many cases *eliminate* high polishing and buffing costs.

You get higher quality, too. Leveling Nickels, when plated semi-bright, are often coated with bright Nickel before chrome plating. The thick, duplex Nickel coating that results assures high brightness and lasting beauty. It provides a mirror-smooth, white-metal foundation for a brilliant blue-white finish. It backs up the chrome and cushions it against cracking — protects basis metals from rust and corrosion.

So with Nickel in ample supply as far into the future as any man can foresee, you can now plan to use leveling Nickel Plating to cut your production costs and enhance plating quality.

For more information about versatile Nickel coatings, write us for our informative booklet, "PRACTICAL ANSWERS TO 40 PRACTICAL QUESTIONS ABOUT NICKEL PLATING."

The International Nickel Company, Inc.
67 Wall Street New York 5, N.Y.

INCO **Inco Nickel** *makes plating perform better longer*

coming next week a PRODUCT ENGINEERING special report

NEW EQUATIONS AND COEFFICIENTS SPEED

DESIGN OF EXTERNAL-SHOE BRAKES

Designers (even automotive engineers) are taking a second look at the external-shoe brake—its higher braking-torque capacity and better heat dissipation. Here is a never-before-published design procedure, a "cook-book recipe" that reduces the usual lengthy analysis time to a matter of minutes. The author is an Australian brake expert—a lecturer and consultant to manufacturers. His method has already changed the thinking of the designers he visited in the US.

Watch for this report in next week's DESIGN issue for November 23.

and in addition next week

the DESIGN issue for November 23

FEATURES

- **Problems and promise of machine tools—1960**
  Over 300 engineers take a careful look at the industry—its current needs, its promise.

- **Logarithmic diagrams solve your problems**
  Prepared quickly, and requiring no special techniques they can be drawn for almost any equation.

- **More work for high-temp reinforced plastics**
  Fundamental behavior of these materials when faced with plasma jet, oxyacetylene torch and rocket engine.

- **16 Unusual O-ring applications**
  In pumps, drives, glands, shock-mounts, pivots, knobs, valves and seals.

- **7 Moment formulas for rectangular frames**
  Aids to stress analysis when rigid frames support various types of loads.

Product Engineering

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT

R&D Research and development news issue

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Product Engineering ..... SIDELIGHTS

R and D Research and Development news issue

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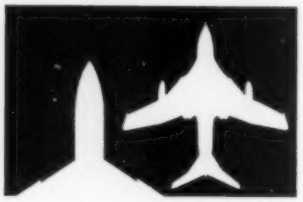

● **Aircraft shapes may get curiouser** (p 32) but, man and boy, we all still dream of some day being able to fly without the nuisance of a "craft" around us. Now science says we can. Dr D R Wilkie of University College, London, calculates "that practical man-powered flight is possible." He figures that a 175-lb man can generate 0.4 hp for from 5 to 30 minutes and that this would be enough to get him off the ground. Up-drafts and currents could keep him aloft. Shades of Icarus—and watch your wings don't melt up there, son.

● **Infant mortality—a failure characteristic** of all systems (see p 27)—is the bane of all prototypes. Other failures are caused by designer errors, some by manufacture, but a goodly number are operator problems (even when the operator is an expert). We were reminded of this when one of our editors returned from a submarine cruise (*PE*—Oct 26, p 115) with the following story. It seems the Skipjack commissioning ceremony was a gala affair. Sightseers lined the dock and banks of the river. Radio and TV announcers rode on neighboring boats, and an admiral watched the whole performance from a helicopter. All went without a hitch. The boat was moving well out in midstream, when suddenly it stopped dead. Attending boats skidded about in confusion and the admiral radioed nervously, "What's going on down there?" Thinking quickly, the captain radioed back, "Just running anchor drill, sir." It seems someone pushed the wrong button.

● **The evaluation of 1960's small cars** (Nov 2, p 32) made no mention of larger models. The following note may indicate why.

To the Editor:

I had my nice 1959 ———— in for minor repairs (tail light) and while waiting stepped into the salesroom where the 1960 models were covered with cheesecloth.

I asked the salesman, "What is new and different over 1959?"

"Well," he said, "the 1960 models have beautiful new bumpers . . ."

I left.

ABP November 16, 1959

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How to select the exact heating element to meet your product requirements

Here's condensed information from General Electric to help you get the most economical heater for your products.

CARTRIDGE HEATERS

• **Applications**—Efficient, self-contained heaters, for use singly to provide a "spot" of heat, or grouped to heat larger surfaces. Perfected for use in process machinery and for localized heating requiring close thermal control: dies, platens, molds, extrusion and injection barrels, gluepots, compound pots.

• **Features**—Durable nickel-chromium resistance wire packed in insulation and sheathed in metal tube.

• **Ratings**—30 to 2800 watts—Sheath temperatures: brass (750F); nickel-silver (1000F); chrome-steel (1200F)—Over-all lengths: 1½ in. to 2 ft.—Diameters: ⅜ in. to 1.293 in.—115v to 230v.

IMMERSION HEATERS

• **Applications**—Offer clean, economical method of heating various liquids in tanks, kettles, jackets and other containers. Suitable for immersion in water, oil, alkaline solutions, nickel, copper, chrome, plating solutions, mild sulphuric acid baths and salt baths.

• **Features**—Long life—Easily installed—Easily controlled—Sealed terminals—Excellent insulation and heat conduction.

• **Ratings**—Both through-the-side and over-the-side models available—Sheath materials: copper, nickel-silver, stainless steel, Inconel and lead—115v to 230v—Wide variety of models from 650 to 10,000 watts.

FIN TUBULAR HEATERS

• **Applications**—Especially suited to forced-convection air heating applications, such as air ducts with forced-air circulation, blower-type electric unit heaters, car heaters, recirculating ovens, industrial processes requiring heated air blasts for drying, baking, testing or pre-heating.

• **Features**—Large radiating surface per unit length—Fins sturdily attached by brazing—Quick heat transfer—Nonoxidizing rust-resistant finish—Durable construction.

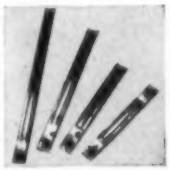
• **Ratings**—Wide variety of shapes available—Sheath temperature: steel (850F)—Watts: up to 100 per linear inch.

TUBULAR HEATERS

Applications—Applicable to practically every low-temperature (1500F or lower) requirement, whether heating liquids, air, soft metals, or metal surfaces. Typical applications: ovens, ducts, platens, pipes, space heaters.

• **Features**—High-quality resistance wire, insulated in metal tubing—Heaters bent to conform to almost any shape, cast into metal, located in drilled holes, grooves, or spaced away from surfaces.

• **Ratings**—Standard ratings, 500 to 5000 watts; special ratings available—Sheath materials: steel (750F); nickel-silver (1000F); stainless and Inconel (1500F); copper (212F in water).



STRIP HEATERS

• **Applications**—Designed for direct clamping to surfaces. Typical applications: process machinery, drying ovens, matrix scorchers, warming tables, glue tables, water baths, drying cabinets, pipelines, incubators, valve and pump houses, telephone switchboards, roll heating, packaging machinery.

• **Features**—Uniform heat distribution—Corrosion-resistant sheath materials—Easy to install—Moderate cost—Uniformity.

• **Ratings**—Provided with offset terminals at one end or terminals at each end—Sheath materials: Aluminized-steel (1000F); Chromized-steel (1200F).

METAL-MELTING HEATERS AND POTS

• **Applications**—Feature cast-in immersion heaters for melting lead, babbitt, tin, solder, type metal and similar metals up to 950F. Applications: dip soldering of subassemblies, railway and repair shops, electric service shops, printing plants, manufacturing plants, remelting metals.

• **Features**—Heat generated right in metal for quick heating, low radiation losses—Heater easily replaced without interrupting production—Reliable, safe, economical—Can be tied in with automatic temperature control.

• **Ratings**—Standard melting pots—Wt. 50 to 2000 lbs—Watts: 750 to 30,000.

OVEN HEATERS

• **Applications**—Designed for such applications as baking, japan, foundry cores, drying, low-temperature drawing ovens, and for general air heating applications in which there is free movement of air by convection. Heaters used in recirculating type ovens for core baking, paint drying, tempering, air heating in ducts, placement inside oven.

• **Features**—Easily mounted on side walls of oven or in ducts—Wide range in heater ratings and combinations of heaters.

• **Ratings**—Temperatures: Two models available: 750F–1000F, and up to 1200F.

VANE-TYPE HEATERS

• **Applications**—Used for air and surface heating applications: baseboard heaters, pipe heating, platen heating, valve and pump heating, drying cabinets and ovens, process machinery, compound tanks.

• **Features**—Rugged tubular construction resists mechanical shock and vibration—Large, 1¾ in. wide radiating surface—Low heat density: 25 watts per linear in. of vane; 14.3 watts per sq. in. of heater surface—Can be easily formed—Convenient mounting holes.

• **Ratings**—Variety of models from 500 to 2500 watts—115 to 230 volts—Over-all lengths: 24 to 104 inches—Maximum operating temperature 750F.

GENERAL ELECTRIC

Section B723-39, General Electric Co.
Schenectady 5, N. Y.

Please send GEC-1005, "Catalog of G-E Heaters and Devices."

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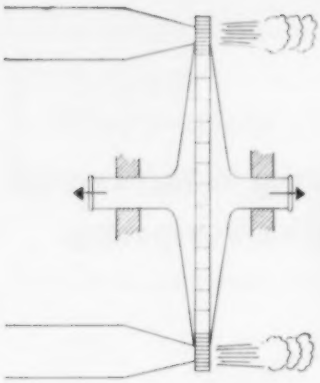

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CUSTOM FLOW DIVIDER SOLVES FUEL METERING PROBLEM FOR TURBINE BUILDER

This multiple unit is a series of custom Roper pumping elements driven in tandem by a hydraulic motor. It accurately meters distillate or residual fuel oils to the combustion chambers in a large gas turbine. These rugged units, used on both mobile and stationary turbines, withstand extreme temperature changes during operation. This unusual application is another example of Roper's ability to tackle — and solve — difficult pumping problems.

If you have an application where a standard pump does not fit your needs, Roper can custom-design and build pumps that meet your requirements. For further information, call the factory or the Roper representative in your area.

ROPER PRINCIPLE OF ONLY TWO MOVING PARTS ASSURES EFFICIENCY . . . DEPENDABILITY

Roper Pumps are the rotary gear type — two equal size pumping gears operating in a case with proper clearance. This factor promotes long service life and optimum performance on all applications.

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Reader To Editor . . .

Creativity

To the Editor:

Your description of the creative man (Aug. 24, p 20) makes him seem strongly an isolate. I wonder if he is really this, or is he merely anti-social from a displeasure of common American social activity and the rather mundane rewards. I have met several creative types who were strong leaders and very social in their own areas. Are these exceptions? Another interesting fact is that some of the tendencies you note are the same found in the ambitious power-seeker. Anti-authoritarianism is easily confused with rule breaking for personal reasons, need for order with organizational control. I see these people on the up grade and a genuine confusion exists in many management circles in this area. Biggest problem—management doesn't know it is confused.

—Edith Meyer
Canoga Park, California

To the Editor:

I note that you conclude that the older man is less creative than the younger man. Was this true of such men as Tesla, Steinmetz, Bell, Edison, etc? The reason I ask is that I have noted that the more creative men in organizations—the more intelligent—tend to assume more managerial responsibilities with a concurrent loss of time to devote to creativity in the sense put forth in the article. Time for creative thinking and doing requires freedom from such mundane matters as financing, budgets, personnel problems, facility arrangements, and paper work with which the older man becomes encumbered. —J T Stacy
Aero-Space Div
Boeing Airplane Co. Seattle, Wash

ME's and Architects

To the Editor:

The first phase of Mr. Penders article, ("ME's Essential to Architecture" Aug. 17, p 43) seemed apropros if there has been friction between ME's and architects. It is only common sense that the two fields are dependent on one another and must work together as a team. But, when Mr. Pender started discussing mobile homes and stated that "mechanical engineers filled the gap by designing mobile homes after the architects laughed at the idea of a mobile home incorporating kitchens and bath rooms,"—then I had to laugh.

I have been associated with or worked in the mobile home field since 1938. Top length then, 29 ft with no baths, today, upwards of 64 ft and double baths. In all this development I have only met one mechanical engineer within the industry, however, there may be a few around.

All these years I have felt a little like an architect—now I find I am somewhat of an ME. —Rodger E. Deckrow
Texarkana, Texas

DEVELOPMENTS TO WATCH... American

Direct conversion of nuclear to electric energy . . .

. . . by means of plasma diodes (*PE*—Dec 1, '58, p 10) will be tested by GE within the next few months. The aim: to explore the possibilities of capitalizing on the high internal temperatures of reactor fuel elements as a means of producing direct electrical power as well as steam. If successful, this could mean an increased power rating as great as 33%—with a significant reduction in power costs.

Also under study by GE's Atomic Power Equipment Dept: sodium module reactors, which feature individual fuel-and-sodium coolant units spaced within a graphite moderator; and at least four boiling-water types.

(Note: For more on GE reactors see p 13.)

Titanium can be strengthened . . .

. . . and its operating temperature raised by metal fiber reinforcement says a report prepared for the Defense Metals Information Center.

At 200 F, says the report, the Ti-6Al-4V alloy, reinforced with discontinuous molybdenum fibers, had a strength-to-weight ratio greater than either Inconel X or A286. Unfortunately, this improvement is a short-term rather than a long-term effect; and, the report says: "Improvement in the long-time strength, as indicated by stress-rupture data, is not so hopeful. Problems remain of protecting the molybdenum fiber from catastrophic oxidation and of the tendency of the molybdenum to go into solution in titanium after long periods of time at high temperature."

There is promise of long-term as well as short-term improvement, though, in dispersion hardening using insoluble particles of such intermetallic compounds as Ti_2Cu and TiC, and such rare-earth oxides as CeO_2.

New lubricants for 1300 F and above . . .

. . . are promised by elevated-temperature friction of such metals as iron, copper, cobalt, and chromium.

The lubricants: "soft" oxides of tungsten, copper, zinc, cobalt, and lead.

Sliding friction tests, reported to the ASLE by M. B. Peterson, J. J. Florek, and R. E. Lee of GE, show that the coefficient of friction of these metals changes markedly above room temperature, sometimes undergoing several well-defined transitions between 200 and 1400 F.

Cobalt sliding against itself, for instance, shows an initial coefficient of friction (at room temperature) of 0.32. This drops to a low of about 0.25 at 500 F, then turns upward, going above 0.5 at 1000 F. Then it drops almost to its original value at 1500 F.

The reason, the GE researchers theorize:

As the temperature is increased and the material softens, friction and surface damage will increase. But when the temperature gets high enough so that the protective oxide film on the surface of the metal is continually reformed, the sliding characteristics markedly improve.

"At a temperature of 1300 F," they conclude, "a number of the oxides of tungsten, copper, zinc, cobalt, and lead are effective as solid lubricants." They add, "There is a relation between the friction properties of certain nickel and iron alloys and that of their major constituents. A reduction in friction has been observed at temperatures which promote oxidation of the least oxidation-resistant component."

Oil-seal design is getting a thorough going-over . . .

. . . as manufacturers and users find that new materials alone won't solve their problems.

As G. L. Corsi pointed out to the SAE National Transportation Meeting, Buna-N rubber (NBR) is normally good for 250 F, polyacrylic for 300 F. But NBR parts can equal or even outperform the polyacrylic if they're properly engineered. Particularly important are sealing-head design that provides for narrow-shaft contact directly under the garter spring, and "bonding" of the rubber to a metal part to minimize deformation during assembly.

In some cases, selection of oils is as important as selection of sealing materials and part design to minimize leakage. "Anti-leak" oils are offered that actually go against normal design procedure. Normally, it's desirable to have an oil which will *not* affect the seal. But these oils are so formulated that they swell the sealing material just enough to prevent leakage—without, it is hoped, causing slippage or deterioration.

(Note: for more on seal design, see (*PE*—Oct 12, p 36 and Oct 26, p 35.) —ARC

Columbium

makes possible

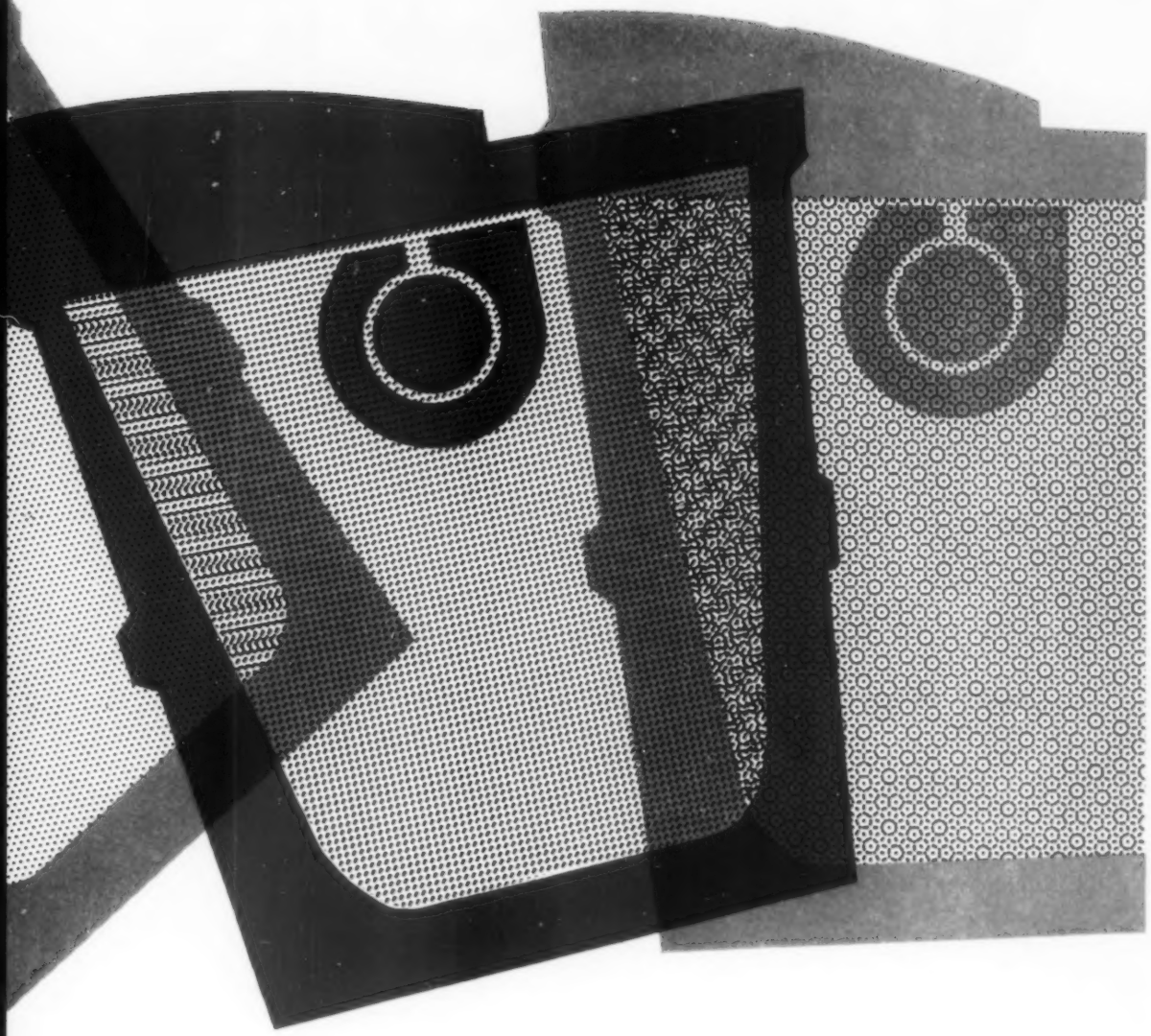
this unique

new

fine-grained

carbon steel

GLX-W



Compare fine-grained GLX-W with the steel you use

Great Lakes adds a precise amount of columbium to good-quality carbon steel. The result is fine-grained GLX-W steel. Here's how GLX-W compares with mild carbon steels . . .

- GLX-W is 50-100% stronger
- Has greater notch toughness
- Has excellent weldability
- Is as ductile as other carbon steels
- Permits designers to reduce weight up to 35%.

For proof on how GLX-W can cut your production costs, write, wire or phone Great Lakes Steel Corporation, Product Development Division, Department P.E. 11-16

GLX W

GREAT LAKES STEEL

Detroit 29, Michigan

A DIVISION OF NATIONAL STEEL CORPORATION

DU PONT VITON®

SYNTHETIC RUBBER

NOW PROVEN IN PERFORMANCE WITH OILS, FUELS, SOLVENTS, CHEMICALS...TEMPERATURES OVER 400° F.

Well over a year ago, Du Pont, a pioneer in synthetic rubber research and development, introduced VITON, a fluoroelastomer with an impressive combination of properties.

Engineers engaged in the design of aircraft, autos, appliances, chemical and industrial equipment were quick to evaluate this new synthetic rubber for use in their own designs.

Today, the improved operation of a wide range of industrial products can testify to VITON'S success. Just as the laboratory reported, VITON *is* resistant to heat . . . in certain critical applications as high as 600°F. And its fluid resistance has been *proved* by a host of commercial applications involving oils, fuels, solvents and corrosive chemicals.

If you haven't already received full information on VITON, write for our new booklet. It outlines the important design properties and details some of the interesting applications that have been found for this new elastomer. E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department PE-11, Wilmington 98, Delaware.

Typical Commercial Applications Where VITON Now Means Better Product Performance

PRODUCT	OPERATING CONDITIONS
Aircraft Fire Seals (coated asbestos type)	Aviation fuel, hydraulic oils, 500° F. temperatures, ozone
Appliance Shaft Seals (washer-drier)	Detergent solutions, grease, hot air at 300° F.
Carburetor Parts	High aromatic content gasolines
Centrifuge Seals	Chlorinated hydrocarbons including methylene chloride
Heat Exchanger O-Rings	Fatty acids at 525° F.
Oil Well Packer Seals	Crude oil at 6000 psi, 300° F.
Pump Diaphragms	Concentrated sulfuric acid
Pump Liners	Concentrated hydrochloric acid
Safety Suits	TEL and missile fuels
Stove Thermostat Diaphragms	Heat expansible fluid at 400° F.
Valve Seats and O-Rings	Benzene, toluene, xylene, 400° F. propane
Valve Stem Seals	Hot automotive lubricants

DU PONT REG. U. S. PAT. OFF. SYNTHETIC RUBBER

NEOPRENE
HYPALON®
VITON®
ADIPRENE®

Better Things for Better Living . . . *through Chemistry*

DEVELOPMENTS TO WATCH...

World-wide

Nickel plating directly on aluminum . . .

. . . at rates to 750 amp/sq ft with good adhesion and ductility is reported by J. T. N. Atkinson of Canada's Naval Research Establishment.

The process is one that has been under development for several years, and the fundamental system is patented; but it has taken a long time to find the key to efficient operation. Now, Atkinson says he has the key: addition of small amounts of nickel chloride to the fluoborate plating solution that is used. Atkinson also reports that care must be taken to prevent contamination of the solution by copper as well as oils and other impurities.

A magnetic material with unusual properties . . .

. . . is being described at this week's Magnetism and Magnetic Materials conference by representatives of N V Philips (Netherlands). It's a manganese-aluminum compound in the 68-75% Mn range with an intrinsic coercive force (IHC) of 600-1200 Oe which can be raised to more than 6000 Oe by pulverizing the bulk material.

Unfortunately, the increase in coersive force accomplished by pulverization is accompanied by a decrease in saturization magnetization, though there seems to be no correlation between particle size and coercive force. Furthermore, annealing the powders reverses the pulverization effect—raising the saturization magnetization and decreasing the coercive force.

Sample magnets have properties like these: IHC: 4600 Oe; BH_{max}: 3.5 x 10^6 g-Oe; B_r: 4200 g.

Improved bearing liners . . .

. . . can be produced by two new powder-metallurgical techniques, say Czech engineers.

In one, powered lead bronze (mean grain size 0.05 mm; max; 0.15) is spread on copper-plated steel sheet in a layer about 1.5 mm thick and pressed sintered at 1500-1600 F for 15 to 30 min. The pressing and sintering cycle is repeated several times to obtain a sliding surface of the highest density.

In the second method, much finer powders are used (max size, 0.06 mm), and they are rolled into sheet, partially sintered at 1400-1600 F and re-rolled for compactness. The sheet so formed is then applied to the copper-plated steel and pressed and sintered again at the same temperature. Pressure is about 140 psi.

The techniques were developed at the Slovak Academy of Sciences and the Research Institute of Powder Metallurgy.

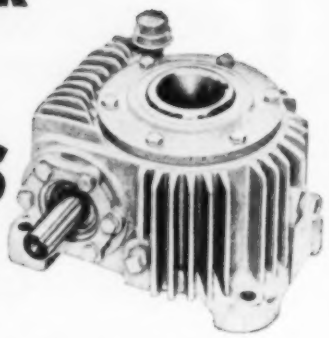
T-nut that can be inserted and removed . . .

. . . at any point along a slot so it does not have to be slid to one end or the other, has been designed in England. The major aim: to simplify assembly of machine-tool work tables, dividing heads, and similar equipment. According to the manufacturer, Kennington-Shanks Engrg Co, 61 Baker St, Weybridge, Surrey, the nuts are automatically self-locking when installed; but can easily be removed—even when dirt and chips accumulate around them.

Kennington is ready to supply them in British Standard sizes from $\frac{1}{32}$ in. across flats by $\frac{1}{32}$ in. long to $\frac{1}{8}$ by 2 in., will make special sizes on request. Prices range from about 50¢ each without knurling to about $1.40 for the largest size with knurling. (Both prices are US equivalent. The nuts can be purchased from England; but there is as yet no US distributor.) —ARG

Self-locking T-nut, for machines having slotted tables or bases, features ease of insertion and removal.

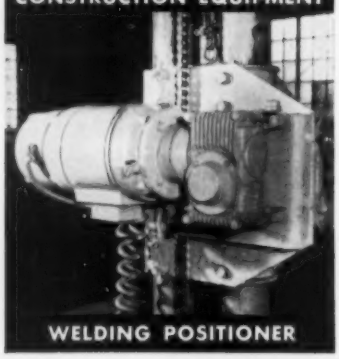
CONE-DRIVE WORM GEAR HOLLOW SHAFT SPEED REDUCERS



provide greater flexibility in the design of your equipment

MIXING MACHINE

CONSTRUCTION EQUIPMENT



WELDING POSITIONER

Standard Cone-Drive hollow shaft speed reducers are available in four basic sizes (2, 2½, 3 and 3½ inch center distance units) to accommodate loads from fractional to 13 horsepower. They are built around the double-enveloping worm gear design and carry the same high ratings as standard Cone-Drive speed reducers.

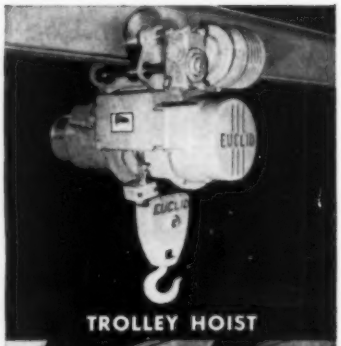
You, as a designer, will be particularly interested in the versatility of application and space savings made possible by the right angle design between input and output shafts.

The reducer is mounted directly on the driven shaft and requires only a simple bracket or torque arm to prevent it from rotating about the driven shaft.

Construction is rugged enough to permit floor or wall mounting of Cone-Drive hollow shaft reducers and "hanging" the driven shaft on it (in certain applications), eliminating pillow blocks or bearings. Larger-than-necessary taper roller bearings and heavy-duty castings make this possible.

If a motorized reducer is desired, a simple, standard bell housing can be furnished for NEMA C-type face motors. The need for expensive couplings is eliminated since a tang-type drive sleeve and suitably machined worms are provided. When a hollow-shaft speed reducer and face-mounted motor are combined, no bed plate or mounting arrangement is required. Pulleys, belts, sheaves, etc., that might be troublesome or difficult to install are also eliminated.

Ask for Bulletin CD-218.



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DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS

DOUBLE REDUCTION WORM GEAR SPEED REDUCERS

DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS

WHAT'S HAPPENING IN... Science

Thermal analysis brings new answers

In metallurgy, ceramics, and many fields of chemistry, thermal analysis, and particularly two techniques known as DTA (Differential Thermal Analysis) and TGA (Thermogravimetric Analysis), is arousing new interest.

DTA is defined as the measurement of temperature differences between a sample and a thermally inert reference compound as the two are cycled through a given temperature range. It can be used to analyze materials, study heat degradation, and develop new materials with improved thermal stability (*PE*—Sep 28, p 24).

TGA deals specifically with measuring changes in weight as a function of temperature and is a valuable adjunct for DTA.

Another thermal technique that's becoming increasingly important is microchemical fusion analysis. This is use of a chemical microscope to observe the behavior of fusible compounds or mixtures during heating and cooling. As W. C. McCrone pointed out to the recent Eastern Analytical Symposium, this technique can provide important clues to both composition and performance. Among its applications: characterization and identification of compounds and studies of crystallographic properties.

At the same meeting, incidentally, Saul Gordon of Picatinny Arsenal gave a good definition of the over-all term **thermoanalysis.** Broadly, he said, it involves "the continuous measurement of effects accompanying chemical or physical changes, resulting from various physico-chemical processes, as a sample is heated to elevated temperatures at a predetermined rate."

It's a cool earth

It's not so hot inside the earth as we once thought, Dr John Verhoogen of U of California is saying in his Sigma Xi lecture—a mere 930 F at the base of the crust (about 25 mi down), about 3600 F at the edge of the core (2000 mi down). Volcanoes, which make the earth's center seem hotter, are just areas of localized heating .

Evaluating temperatures inside the earth is not a simple matter, particularly since we don't know very much about the relevant thermal conductivity. Best way to get around the difficulty seems to be an evaluation based on elastic properties and density as they are affected by temperature changes. But it's going to take a lot more study and a lot more drilling (*PE*—Jan 12, p 14) before we can be sure that even the best estimate is close to the mark.

New way to make oxygen

Oxygen can be obtained directly from air by chemical means, say Bureau of Mines researchers. Chemical sorption processes can not replace tonnage oxygen liquefaction plants; but they could form the basis for design of smaller shipboard, electrical, and welding equipment.

The chemical route to oxygen production is not a new idea. It received a good deal of attention during World War II; but research was abandoned shortly thereafter. Now, the idea is being revived, new sorption compounds being investigated; and new economic studies made.

Surprisingly, the most practical compound — from an economic as well as a processing point of view— seems to be one of the oldest: salcomine, a cobalt-containing complex. (Full chemical name: bis-salicylaldehyde ethylenediimine-cobalt).

As compared to liquefaction plants, salcomine units would not be cheap; but they would have advantages:

The equipment is light and compact, so plants of relatively small size can be constructed; and, once started, they will produce oxygen almost immediately. They are "ideally adapted to intermittent service," Bureau of Mines researchers report.

One interesting sidelight: action of the salcomines in reacting reversibly with oxygen—taking it up and releasing it when heated to a critical point or on some other "signal"—is similar to the action of hemoglobin in transporting oxygen through the body.

atom briefs . . .

Water is the heat sink, and a radiation shield as well, in a reactor safety system now being developed by GE for reactors of the "boiling water" type (see p 7). In this system, the reactor itself is placed inside a containment pool, so designed that, in the event of a fast energy release that breeches the reactor vessel or piping, the water will absorb energy by condensing the reactor-produced steam and thus prevent an excessive pressure rise. If successful, says GE, the idea may reduce the cost of reactor containment and shielding considerably.

Process heat reactors that might be used to gasify coal or supply heat for chemical process, have been studied by Bureau of Mines researchers.

Much remains to be done before such a reactor can be built; but their report of preliminary investigations makes interesting reading. Especially worth noting is a table of properties of "inert" gases.

Copies of the report, Bureau of Mines Information Circular 7920 (16 p; mimeo) are free from Publications Distribution Section, Dept of the Interior, US Bureau of Mines, 4800 Forbes Ave, Pittsburgh 13, Pa.

The Indian Point power plant and the basic nuclear facts behind its operation are simply and attractively outlined in an 8-page booklet prepared by Consolidated Edison of NY. Scheduled for completion in 1961, this 275,000-kw plant will be a presurized-water unit, using a mixture of uranium and thorium oxides as the fuel and graphite as the moderator. The booklet is available free of charge from Con Ed, 4 Irving Place, New York 3. —ARG

EXTENSIVE DOW PRODUCTION FACILITIES FASHION VARIED NEW MAGNESIUM WARES

Coiled sheet, thin wall castings, many other production items are now available from Dow's big rolling mill, foundry and fabrication facilities.

Manufacturers on the alert for improved materials and production methods would enjoy a quick tour of the four Dow plants that turn out magnesium products. New ways of forming and fabricating magnesium now being practiced in these plants open up new areas of use for the lightweight metal.

TOOLING PLATE, extra flat, is annealed to eliminate residual stresses.

At the huge Madison, Illinois, rolling mill, for example, they're making magnesium sheet that doesn't require stress relief after welding. This is a major step forward in light metal technology and a boon to manufacturers using magnesium assemblies. Madison has also increased the maximum width of sheet to six feet. Five different sheet alloys, including elevated temperature alloys, are now available either flat or in coils.

To keep abreast of the rapidly increasing demand for precision jigs and fixtures, Madison keeps a close watch on the tolerances of Dow magnesium tooling plate. Typical flatness tolerances, for example, are 0.010 inches in any six feet. This means greater accuracy and less machining for users of Dow tooling plate. A mammoth 13,200 ton extrusion press, also located at Madison, is now turning out magnesium extrusions up to 30-inch circumscribed circle in size.

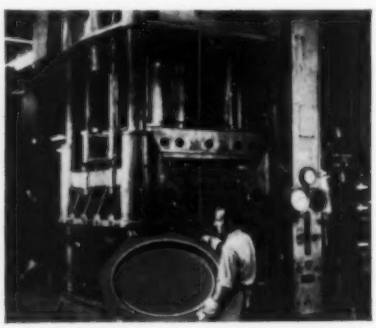
Over in Bay City, Michigan, interesting things are happening, too. At the well-equipped Dow magnesium foundry, largest in the U. S., sand and permanent mold castings of all sizes and shapes are being produced on a volume basis. Complete facilities are maintained for heat treatment, styrene DMI impregnation and chemical treatment. A well-staffed quality control team makes sure that all specifications are met or exceeded, and that the most modern equipment and techniques are fully utilized.

The Bay City foundry casts many complex and difficult designs. Large castings with walls as thin as 0.100 are now being produced. Other useful developments include cast-in tubeless passageways for use as hydraulic lines, special coring techniques for casting enclosed shapes and new magnesium casting alloys.

A new die casting plant is now on stream at Bay City. This facility houses the most advanced magnesium die casting equipment, including cold chamber metering units which automatically feed metal to the machines and contribute to unusually high production rates. To assure close alloy composition control in both die casting plant and foundry, a direct reading spectrometer provides frequent and precise analyses of the molten metal. Similarly, X-ray equipment is also available where radiography is needed in quality control.

The Dow fabrication plant, also in Bay City, offers capacity for volume work on magnesium assemblies. Here, too, developmental work on magnesium is constantly in progress. The plant is set up to handle large or small jobs, and plenty of both. Its activities include deep drawing, bending, spinning, stamping, piercing, machining, arc and spot welding, assembly, chemical treatment and painting. This plant has pioneered many "firsts" in magnesium production, such as hot drawing, spot welding and automatic welding.

DOW FOUNDRY offers production capacity for sand and permanent mold castings of all sizes.



LARGE DRAW PRESS at Dow's fabrication plant forms magnesium sheet in one operation.

WRITE TODAY for more information about Dow's magnesium production facilities. Request "Fabrication Brochure", "Foundry Brochure", "Die Casting Brochure" or all three. THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Sales Department 1351DZ11-16.

DOW

THE DOW METAL PRODUCTS COMPANY
Midland, Michigan
Division of The Dow Chemical Company

WHAT'S HAPPENING IN... Materials

New route to purer materials

A thermal separation technique that does not involve ultrahigh temperatures, and promises to be useful for plastics and chemicals as well as metals and minerals, is under test at International Salt Co.

Originally developed as a means for purifying rock salt, the technique is surprisingly simple and effective.

There are just two basic steps: Selective heating by radiation, and separation by means of a heat-sensitive surface.

As International Salt points out, some materials are "transparent" to infrared radiation while others absorb it in varying amounts. Rock salt, for instance, is transparent; while most of its impurities are not.

If, then, a rock-salt mixture is exposed to infrared radiation, the salt crystals will remain relatively cool; while the impurities will heat up. Then, all that's necesary is to pass the mixture over a high-speed, resin-coated conveyor belt. The impurities soften the resin just enough so they stick to it slightly, retarding their progress; while the rock salt moves swiftly ahead.

At the end of the belt, then, the salt flies off into a bin some distance away; while the impurities, having been slowed down by adherence to the resin, drop limply into a bin right next to the belt.

That's all there is to it. But it took many years to find the right combination. Now, International Salt has the system in one operation at one mine; plans to extend it to several others.

Future structures: four-in-one?

Combination materials may be the best solution to the complex design problems posed by high temperatures and high and low pressures, says C. W. Kniffin of ARDC.

For space ships, he says, the structural material-of-the-future may have to be composite of an expendable external ablative coating, a ceramic layer, and a refractory metal—all on a basic titanium or steel frame.

The ablative coating would serve as the "first-line temperature defense;" and, ideally, would be one that could be repetitively applied to a vehicle surface by a simple spray process—much as undercoating is now applied to automobiles—to compensate for losses during vehicle operation.

The ceramic layer—perhaps also sprayed on—would provide thermal insulation and oxidation resistance.

The refractory metal would provide heat transmission and skin strength.

Plenty of problems remain to be solved, Kniffin points out, before such materials are ready for use, particularly in regard to compatibility of the materials themselves. Expansion coefficients, for instance, must be matched; and corrosive combinations avoided.

briefs . . .

For prototype electronic parts, try boron nitride, suggests Carborundum Co. It is readily machinable, has a uniform and flat dielectric constant over a wide temperature range; and can be used to 1800 F in air and to 3000 F in reducing atmospheres. It is also highly corrosion resistant and inert to such semiconductor materials as silicon, antimony and lead.

At 1 megacycle, dielectric constant is 4.15 and loss factor, 0.008; room-temperature resistivity is more than 10^{12} ohm-inches; coefficient of thermal expansion, 0.4 x 10^{-6} in/in/°F.

Alnico V can be shaped into rod, wire, and thin strip by hot working, says C. L. Kolbe and D. L. Martin of GE's Research Lab—and the resulting materials equal cast magnets in their magnetic characteristics and have even better mechanical properties. They've made long lengths of wire, and strip down to 0.005 in. To secure workable materials, though, it's necessary to control alloying (especially Al, Ti & Zr), and processing.

Ductile ceramics research reports, describing basic studies of crystalline surfaces previously outlined here (*PE*—Sep 21, *p* 14) are now available from NASA. They describe the relatively high degree of ductility exhibited by crystals immediately after cleavage, outline treatments (notably with silver) that seem to enhance ductility and retard its loss. The reports, prepared at Lewis Research Center, are D-75 and D-76, available from NASA, Washington DC. —ARG

Plastics: key to conductor life

Spacers of glass-reinforced polyester that won't cold flow, Mylar (polyester film) and melamine-impregnated linen sleeving, butyl insulation that will last "more than 20 years"—these are keys to the proud claims of long life, safety, and short-circuit strength (50,000 v rms) made by Bulldog Electric for its new XL bus duct.

Gone are cold-molded and porcelain insulators, ordinary rubber sleeving and all the old standbys—including copper. The duct is aluminum, like 70% of the company's current production. It's an important reminder of a major design trend.

Plastic spacers can take a ton of pressure without cold flow, resist tracking as well.

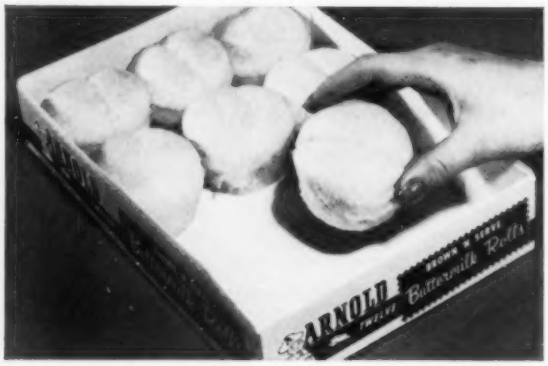
1 This bottle molded of tough polyethylene carries:
(a) alkali *(b) acid for dry-shipped batteries*
(c) water

2 They're big and juicy when polyethylene film is used for:
(a) packaging *(b) mulching*
(c) hothouse glazing

Can you pass this test on Polyethylene Plastics?

(You'll discover more of their potential as design materials)

3 It's the new Atlantic cable, insulated with polyethylene for:
(a) dielectric strength *(b) flexibility*
(c) underwater identification



4 This muffin box is coated *inside* with polyethylene to:
(a) make it moisture-proof *(b) prevent grease staining*
(c) please the housewife

5 The familiar garbage can—a product polyethylene modernized:
(a) three ways *(b) four ways*
(c) five ways

ANSWERS... *to an increasing range of needs are found in BAKELITE polyethylene plastics.*

1. (b) Battery acid—unbreakable polyethylene bottles are inert to almost all chemicals.
2. (b) The mulch controls weed growth, keeps soil moist, berries off ground. Hothouse glazing and packaging could help too.
3. Check (a) and (b). It's water-proof, too, of course.
4. (a) and (b) are right—so (c) is a natural.
5. (c) Five important ways—non denting, light weight, integral color, less noise, and resistance to chemicals.

If you have questions—about designing with plastics for function, serviceability, economy and appearance—please ask us. We'll be glad to answer on the practical design and engineering uses of vinyls, epoxies, phenolics, styrenes, and polyethylenes. Just write or call any of our offices or write Dept. KX-02D, Union Carbide Plastics Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 7.

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Product Engineering HORIZONS

November 16, 1959

TIKNIK TECHNIQUE

This week, engineers at a meeting in Boston will hear of yet another off-beat (and in this case it's the right word) application of engineering, another case in which engineering has gone far afield. Wilson Greatbatch will talk about the "Tiknik", which turns out to be a "transistorized artificial cardiac pacemaker suitable for permanent implantation." That to us means an artificial timer for the heart, and it joins the long series of engineering contributions to medicine.

There are such obvious ones as the cardiograph and other test and recording instruments, the tools and machinery that are to be expected—based on a medical idea merely translated into equipment by the designer. But there are also metal inserts for bone, plastic joints, artificial heart and kidney, iron lung, various prosthetic appliances which are *not* "to be expected." And in which the engineering contribution is very great. These arise from interest rather than direction, in many cases have been the result of hobbies.

The problems of surgery have intrigued and interested many engineers, particularly since development of miniature mechanisms and components, materials of very diverse properties, and products that lend themselves to medical applications. It was a mechanical engineer in Philadelphia who developed the first artificial leg of shaped aluminum tubing, with reshapable plastic socket, ball bearings, a skin-color plastic covering that defies detection, and a weight only a third that of wooden leg. Engineers at various companies have worked out the practical new types of pumps, tubes, heat exchangers and the like for medical use. Engineers working with doctors at the National Institutes of Health, Bethesda, Md., have one of the finest experimental machine shops you could find in the country, and some of the best mechanics. They've gone far in producing electronic replacements for damaged areas of the brain. Modern medicine has, in fact, become heavily dependent upon design engineering.

Our point is, however, that this is by no means unique. In a civilization that is itself moving toward technology at an accelerating rate, engineering is moving into all the professions and specialties. Machines and tools for other disciplines are expected to come from design engineering, but there is more, much more, than that. The dentist, the architect, the teacher, the stylist and decorator all use engineering today. So does every craft and business.

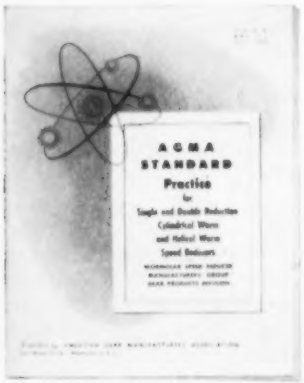
Consider architecture: Cantilevered structures, curtain walls, heat-treated bolts to replace rivets, metal and foam insulation, electrified kitchens, air conditioning. There are endless new plastics and metals, machines that make the tall building, the super-highway and the big dam possible. Or take furniture: The design itself utilizes mechanical principles, and the materials are plastics, plywood, light metals and fibers. There are magnetic drawer pulls and fasteners, new hinge types, laminated surfaces. Or interior decoration: Metal and glass cloths, stainless, monel, plastics and plywood again, to say nothing of new adhesives, paints and coatings.

Perhaps this "Tiknik" is more symbolic than one might at first suspect. Engineering itself is a Tiknik too, providing the timing and the life flow for the greatest civilization our world has ever witnessed.

That's a vital responsibility and a sobering thought, even for a non-mechanized brain.

DE LAVAL offers new A.G.M.A. Gear Standards Booklet for Engineers

You will not want to be without this newly published American Gear Manufacturers Association booklet. It outlines the new standards for single and double reduction cylindrical worm and helical worm speed reducers.



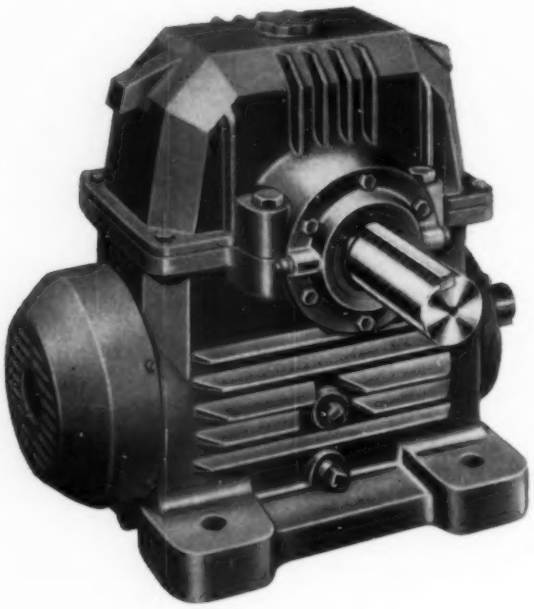
Get this new A.G.M.A. 440.03 booklet free of charge by request on your company letterhead.

This new standards booklet contains important design data including: Power rating of worm gears • **Ratio** correction factor (Km) • Materials factors (Ks) • Velocity factor (Kv) • Coefficient of friction(μ) • Thermal factor • Service factors • Efficiency • Overhung load capacity • Lubrication.

The materials factor (Ks) and the coefficient of friction (μ) are new, reflecting the latest advances made in worm gearing in the past few years.

We have also recently published our new Delroyd Worm Gear Sets Catalog 3800 and Delroyd Single Reduction Worm Gear Catalog 3805, which contain comprehensive information on the selection of these units.

De Laval furnishes worm gearing under the trade name DELROYD and has a complete line from 1⅛″ to 36″ center distance, in horsepower ranges from .04 to 700 and in ratios from 5: to 4900:.



DE LAVAL *Steam Turbine Company*

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Engineering Triumph—Design of Navy's Giant Telescope

WASHINGTON—"Design and construction of the 600-ft-dia parabolic antenna presented a unique engineering challenge," Capt F. C. Tyrrell told engineers attending the ASCE meeting here. Capt Tyrrell, resident officer in charge of construction at the Naval Radio Research Station, outlined a partial list of 14 major engineering problems that had to be solved before the radio telescope could be erected at Sugar Grove, W Va. The problems included: structural, drive, control and radio interference. (*PE—June 8, p 37.*) Some solutions follow.

TWO-WAY TRUSS

Alternate studies of one-way, two-way, and radial truss, ring girder, and space frame systems led to selection of the two-way truss for its greater stiffness and better distribution of loads. Problem of designing a bracing system to transfer a 12,700,000-lb horizontal wind shear force through the structure to the concrete pintles with minimum lateral displacement was solved by using a V-shaped fixed portal attached to the altitude wheels at the plane of the bottom chord of the superstructure truss system. Wheel rotation about the fixed portal and transfer of horizontal load are through massive thrust bearings.

Two-way truss system has as many as 13 major members meeting at a joint. Stress transfer is through pairs of heavy gusset plates reinforced by diaphragms and stiffeners. Structural steel is shop-welded; high-strength bolts are used for field connections.

Allowable tolerances for the antenna surface are only a fraction of the differential movement between the steel frame and the aluminum antenna surface resulting from dead load, wind and ice loads, temperature changes and torsional strains. Antenna surface is expanded aluminum mesh that forms a rectangular grid. It is supported by welded tubular aluminum trusses that form panel units 55 ft sq and 10 ft deep. Panel supports are reversible screw jacks at the corners. Jacks allow corner adjustments to maintain a true parabola surface about the antenna axis.

ALTITUDE AND AZIMUTH DRIVES

The altitude drives support the total dead and live loads of the antenna above the turntable and give 90° antenna rotation. There are 16 drive units in a cluster, 8 bearing against the inside and outside tire of each rim of the wheel, or a total of 128 units. Several degrees of freedom are designed into the drives to accommodate irregularities in the tires and rims. Backlash is zero in the fore and aft direction and the assembly is designed for a high spring constant. Drive wheels are slaved to the track for full bearing between wheel and track.

A hydraulic system interconnects all drive units in a cluster to give load equalization between units. This system also allows lowering of the antenna structure onto stowing pads to relieve the drive units from overload and to permit removal of drive units for repair and maintenance.

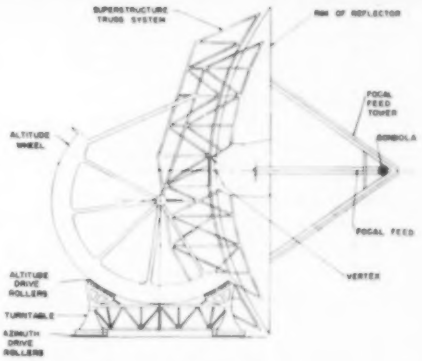
Azimuth drive system is similar except that the antenna operates through 450°. Total live and dead loads are transmitted to the two azimuth tracks through clusters of wheels located at the corners of the turntable truss; however, only the outer wheels are driven.

Both drive rollers are powered by an induction motor, two opposed eddy-current clutches, and a gearbox. Total gear reduction is 526:1 and the gear train is designed so that the clutches are always connected to the train and oppose each other to eliminate backlash. Driving torque, in either direction, is controlled by varying the exciting current to the eddy-current clutches.

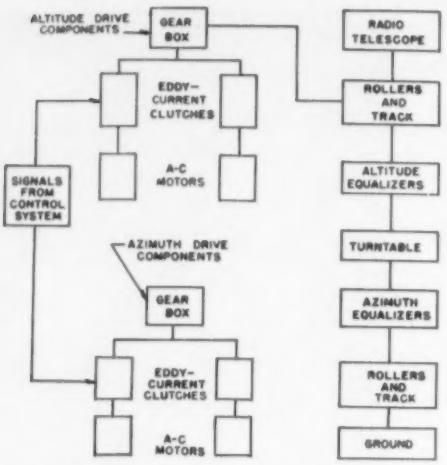
ANTENNA CONTROL

An Inertial Reference System using an inertial platform gives information on where the axis of the telescope is pointing in altitude-azimuth coordinates. Basic elements of the platform are gyroscopes. To keep the platform level with respect to the earth, accelerometers sense gyro tipping from horizontal and feed a signal to torque generators to reset the gyro level. Gyrocompassing is used to sense azimuth direction.

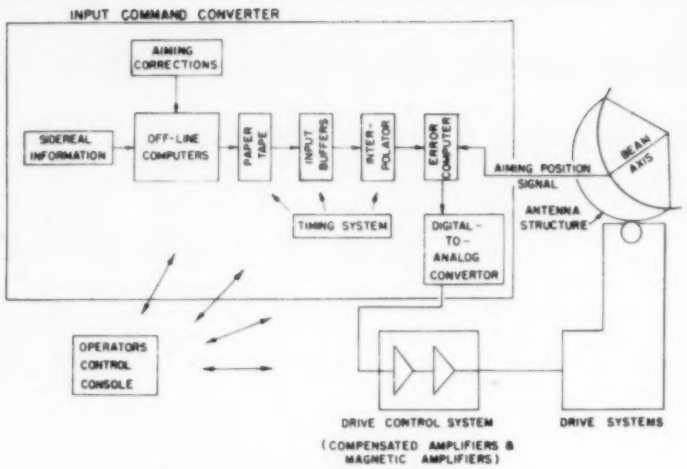
An Input Command Converter defines the track in altitude and azimuth required of the antenna for any particular program. Converter consists of a digital computer and several special-purpose digital units to convert the



Telescope superstructure . . . is supported by two altitude wheels of 190 ft radius. Each wheel has two rims 50 ft apart. These are dual web plate girders about 3 ft 6 in. wide and 30 ft deep, supporting two rectangular steel billets, 10 in. wide and 4½ in. thick, which serve as tires. Turntable truss rests on the azimuth drive rollers which bear on steel rails 10 in. wide and 4 in. deep. Rails are supported on two circular foundations. Turntable rotates on a mass of reinforced concrete 95 ft dia and 20 ft deep.



Drive system . . .
block diagram for altitude and azimuth control. Power train for the drives have zero backlash and are capable of producing a maximum tracking torque at rim speed varying from zero to one rpm.



Aiming and control . . .
block diagram. Error computer accepts signals from the command section and from the angular readout device located at the vertex of the antenna. Comparison of the magnitude of these signals is used to generate a correction signal.

output of the computer into a control signal which is then converted to a correction signal.

Altitude and azimuth drives receive the correction signal which actuates the drive motors and moves the antenna. Control system is electrically compensated to render it stable under all reasonable conditions. This is done in the electrical portions of the drive system prior to the point where driving torque is applied to the antenna.

OTHER RADIO TELESCOPES

Not far from this Naval installation are the 85-ft and 140-ft radio telescopes at Greenbank, W Va (*PE*—Dec 7). Sponsored by the NSF, and under operational direction of the Associated Universities Inc, these are for basic research. An 85-ft telescope, similar to the Greenbank unit, has been completed at the Univ of Michigan under sponsorship of the office of Naval Research.

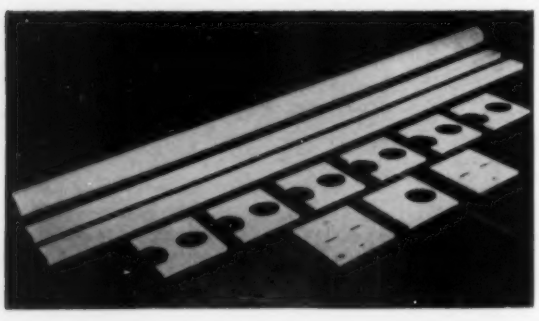
To date, the 250-ft-dia radio telescope at Jodrell Bank, England, is the largest device in use; however, the Soviet Union recently reported it is building a cross-shaped radio telescope with arms about 3300 ft long. This unit is said to be under construction at the Labedev Physics Institute. ■

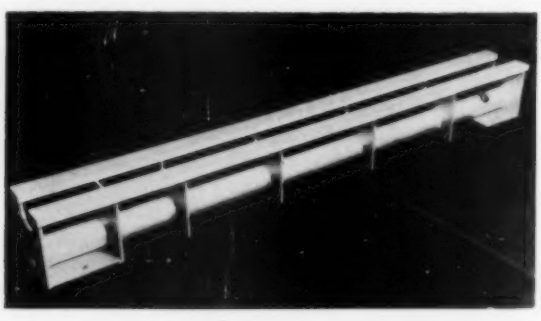
Award-winning Lathe Bed Cuts Costs by 35%

CLEVELAND—A tubular-supported bed designed for a 5-ft wood-turning and metal-spinning lathe to make use of arc welded components won first prize of $10,000 for an Oliver Machinery Co (Grand Rapids, Mich) engineer in the Third Annual Machine Design Award competition here. Some 72 engineers from 54 companies participated in the $50,000 award program, sponsored by the James F. Lincoln Arc Welding Foundation, Cleveland.

Seeking to give the lathe the required torsional rigidity, Oliver Machinery Co designed the longitudinal support, left photo, with 2¾ in. OD mechanical seamless welded tubing of hot rolled, pickled and oiled steel with 0.120 in. wall. Standard ¾-in. flat cold rolled bar stock is used for the two ways.

Supporting the ways are seven 6 x 6-in. stamped ⅜-in. plate cross members, punched out to permit the tubing to run through them. Two base plates at either end are stamped from ⅜-in. cold rolled plate, suitably drilled for mounting bolts. Entire assembly of only 12 pieces is clamped successively in two special welding fixtures while the joints are welded manually with ¼-in. fillets, right photo. The first fixture sets cross members





squarely to the tubing; the second fixture positions the ways on the cross members.

No machining of the four side faces is necessary if the two ways are perfectly straight and equally spaced in two parallel vertical planes.

Welding of cross members to the tubing is confined to the sides, leaving the top and bottom free of weld to avoid distortion in the now-straight plane. The rigid, powerful welding fixture permits use of standard tubing with commercial tolerances for straightness of ⅛ in per 5 ft of length, and keeps tubes within 0.001 in. of straightness and parallelism during welding.

The redesigning enables Oliver Machinery to reduce its lathe production costs by 35%. A conventional cast iron bed for the same type of 5-ft lathe weighs 156 lb and costs $47.25 for material and labor. The welded steel bed weighs 102 lb; material and labor costs are reduced to $24.52. ■

Diecasting Experts Put on Griddle

NEW YORK—Diecasters and diecasting materials suppliers got an earfull of problem questions from nearly 500 design engineers in an unusual "design clinic" conducted by the American Die Casting Institute last week. Engineers from such industries as autos, electronics, business machines and elevators fired questions like these at the 8-man panel of experts:

• Q: What's the status of vacuum-diecasting for less porosity and higher properties? A: No process yet scrutinized by ADCI has come up to claims made. Tests run by ASTM team show that, so far, vacuum produces no discernible improvement in either area. However, a new technique is being developed by ADCI.

• Q: Why can't good surfaces be obtained over a whole run, particularly on brass and other copper alloys? A: Heat-checking of dies due to the high melting temperatures of these alloys is the problem. Development of better die steels is moving slower than expected.

• Q: What aluminum alloys are best for highly alkaline environments? A: High-purity Mg-Al alloys are best such as 218 and A-214. New alloys are expected soon that will anodize well for this.

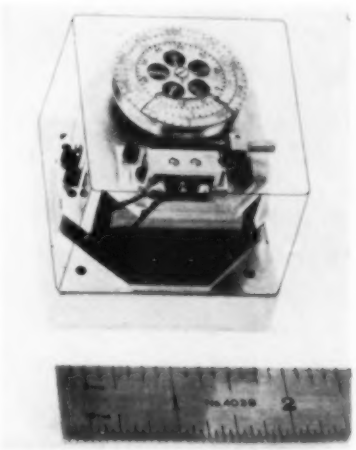
• Q: How are machined castings sealed against porosity? A: With organic sealers like polystyrene or inorganics like sodium silicate; vacuum plus pressure, or direct pressure alone forces coating into pores.

• Q: What Al alloy is best for post-forming operations (spinning, staking, etc)? A: Type 364. ■

College Juniors Now Flock into Math

WASHINGTON—A phenomenal gain of 31% in junior-year student registration in mathematics is highlight of the second annual survey by the office of Education of the US Dept of Health, Education, and Welfare. Other college gains included: 6.2% in the biological sciences; 3.8% in the physical sciences; an 18.5% increase for "science, general program." Presumably, but not necessarily, a substantial portion of this group is headed for science teaching at the secondary-school level.

Among the physical sciences, the largest gain took place in physics, with junior majors increasing 10.9%. In chemistry, enrollment rose 3.2%, but in geology it dropped 10.7%. ■



Transmitter Timed for Year in Space

A 2¼-lb silencer, designed by Bulova Watch Co for the Army Ballistic Missile Agency and which develops one-billionth of one horsepower, is capable of turning off the solar-powered transmitter of the Army's Explorer VII after a year in orbit. Meeting requirements of minimal weight, the tiny shut-off device is fully transistorized and can be set to turn off at any time up to 9000 hr.

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As stated above, this piece, taken at random from a large shipment, was a routine job but a neat one. We are showing it as a good example of the kind of work we do.

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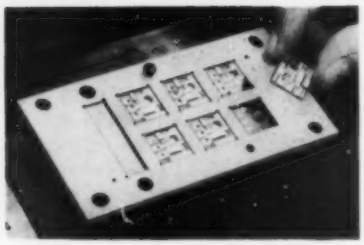


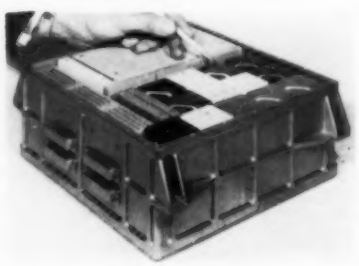
Film Research Reduces Computer Size

PHILADELPHIA—Electronic components of molecular size and essentially weightless are in an advance stage of development at International Resistance Co here. These are the passive elements of an electronic circuit—resistance, capacitance and inductance. The components (above) were developed for a missile-borne computer now under way at American Bosch-Arma Corp.

In these electronic elements an exceedingly thin film of component material is deposited on a tiny substrate of glass, smaller than a postage stamp. Glass was chosen for the substrate because of its structural strength and smooth surface. The circuit is an outgrowth of a decade's experience in film technology at IRC. Components are now being made with constant value tolerances of ±5%, but closer tolerances are possible.

Arma Corp has designed the microcircuits into a computer (below) that is presently in mockup stage. The computer, no larger than a small portable typewriter, weighs 15 lb with a volume of 0.35 cu ft, yet contains as many as 50,000 parts. The unit will be 1/20 the size and weight of comparable units now being made for flight applications. It will handle 20,000 additions or 3000 multiplications/sec, and will be able to store 40,000 bits of information.

The computer, its makers say, will have a reliability of 1000 hr to mean failure. And it will be easy to maintain as well as to produce. ■



Industrial R&D Upped, Japan Sidesteps Reds

TOKYO—Japanese government has announced another step—creation of a Science and Technology Foundation—in its effort to speed up Japanese research, and at the same time quiet leftist critics in Japan's Science Council. Although a spokesman denied that the new body was competitive to the Science Council, observers believe it is another move, coupled with creation of the National Science Advisory Council this spring, to gain support of the government's research program. (*PE—Sep 14, p 37.*)

The government spokesman said the new body would represent financial, academic, and public interest circles here, in Nagoya and in Osaka—Japan's principal industrial research centers. Primary aim of the new body is industrial research as opposed to government research activities. Japan's Science Council has been the "watchdog" over government research.

Foundation will get a $500,000 grant for the next fiscal year beginning May 1 and also expects about $3 million in contributions from interested business organizations. Official announcement emphasized that the Foundation would seek to cooperate with foreign technology. Japanese research ties with overseas companies and foreign governments—especially the US—have been the main targets of the Council leftists. ■

Fluid Power, Control . . . Where Next?

CHICAGO—Every phase of hydraulics came under scrutiny during the 2-day National Conference of Industrial Hydraulics sponsored by the Illinois Institute of Technology. Fluids, filters, strainers, seals, packings received their share of attention, but pumps, motors and high-pressure hydraulics provoked the most interest.

PUMPS AND VALVES

Automatically controlled pumps and valves are playing an increasing role in industrial hydraulic systems. In the next decade, predicts John Pippenger of Double A Products, agricultural, ground support, mobile and even water-borne equipment will demand larger amounts of fluid power and control.

Paul C. Mortenson of Vickers, Inc,

EVERY successful man whose interests are allied with the product design field recognizes the need to be well-informed. As a reader of Product Engineering, you keep up-to-date on all the important trade news that can affect you, your company and your competitive position in your industry.

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Will there be legislation to curb consumer spending, raise interest rates? How significant is the "talk" in Senate halls to raise or lower tariffs? Will we accept Russia's challenge to "peaceful competition" – and how will *your* industry be affected? To what extent, if any, will the presidential election change the nation's economy? What would an increase or decrease in the consumer price index do to your industry?

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BRIDGE SLOWS SIX TRAINS

Traffic Waits for Stuck Drawbridge

Four passenger trains and two freight trains were delayed yesterday up to thirty-eight minutes when a main line drawbridge remained open through electrical failure.

The trouble, which began about 3:40 P.M., was not cleared up by 4:15. Normal service was maintained during the commuter rush period, according to a road spokesman. Inbound and

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sees the hydrostatic transmission (positive displacement as opposed to a conventional torque converter) in many future designs of mobile equipment. It has the advantage, he says, of greater power in smaller space because of higher pressures. It is not competitive in initial cost and total space with conventional geared shafts, but it gives more precise control of output speed, smoother speed changes, and eliminates awkward shafting.

Flow-meter-controlled servovalves—an old concept, previously considered impractical—got a new boost in a paper by Eugene Bahniuk, Pesco Products. Two flowmeters integral with the servovalve move a distance proportional to the flow, and, therefore, supply position feedback to the input element. The valve is relatively insensitive to input supply pressure—response with 500 psi supply is virtually identical to that with 3000 psi.

An advantage is smaller size, possible because rated flow is available through the range of input pressures and over-sizing is not necessary. Response is about identical to a servovalve of same rating without flow meter feature.

Servovalves, in general, were criticized and praised by many speakers during the technical sessions. The concensus was that a servovalve should never be used if a simpler, lower-cost method will work.

SERVOMOTORS

A new contender is a contoured, reversible-cam vane motor to be made by Hamilton Div of Bendix Aviation Corp. C. B. Sung of Bendix said the motor was originally designed to be a pump, but was modified to fill the need for a low-cost, high-response servomotor. Its response frequency at 90° phase lag is 100 cps using a 6.2 gpm valve.

Another novel hydraulic motor, exhibited by Hartmann Mfg Co, Racine, is basically a cylindrical rotating vane-piston with a drilled rotor to permit radial inflow of fluid. The motor turns smoothly from 1 rpm to 2000 rpm. There is a continuous and constant pressure against the moving vanes at all times—behaves as a piston except the motion is rotary.

HIGH-PRESSURE HYDRAULICS

3000 psi seems to be the acceptable upper limit in the opinion of many manufacturers and designers of industrial equipment. Some speakers predicted much higher pressures.

Wesley Masters, Dynex Co, is greatly in favor of pressures at least to 6000 psi. To emphasize his point: there are countless systems already in service with pressures over 5000 psi; hydraulic jacks reach 10,000 psi.

Candid remarks that followed Masters' talk indicated that for ordinary industrial applications, the weight saving allowed by 6000 psi vs 3000 psi pressures does not compensate for the increased expense of special pumps and valves. The fact is that each application must be evaluated on its own merits, and that is the plan that Masters suggested. ■

Process-oriented R & D Available to Industry

NEW YORK—A corporate service which will give reliable data that engineers need to design fully commercial processes, and which seeks to obtain R & D results quickly and inexpensively, has been introduced by M W Kellogg Co.

According to Kellogg officials, the new service offers to a wide segment of industry an R & D team oriented toward process rather than product development, and techniques, such as cross-fertilization of disciplines, which makes research more efficient.

Kellogg says that compensation for the service will be based on an evaluation of the commercial applicability of a process rather than on time spent or service performed. ■

High-Temp Resistance Thermometry Tested

WASHINGTON—The National Bureau of Standards has developed a platinum resistance thermometer for interpolating between fixed points on the International Temperature Scale (ITS) above 630.5 C, the melting point of antimony. In addition to simplifying and smoothing the scale, it is expected that its use at temperatures up to 1063 C (the gold point) will give greater precision and reproducibility than is possible with present thermometric instruments.

Present platinum-rhodium thermocouple, used for this ITS range can measure with an accuracy of only a few tenths of a deg. New thermometer has a drift of less than 0.001 C/hr at 1000 C, and has been tested for mechanical shock conditions. ■

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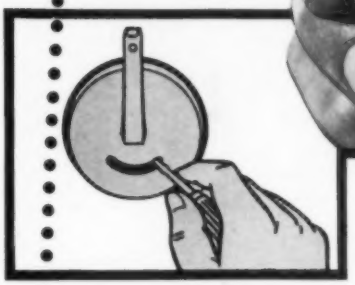

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The Marsh Pocket Thermometer is a simple but reliable instrument for all-purpose use. It is invaluable for checking temperatures in home freezers and refrigerators, commercial walk-in boxes, heating jobs, and general thermometer use. It is non-breakable, easy to read, low priced. To maintain accuracy, the "Recalibrator Slide" on the back permits easy adjustment. The actuating coil element is Chace Thermostatic Bimetal.

It is obvious that many of the uses of Chace Thermostatic Bimetal are of the workaday variety far removed from the romance of missiles, interplanetary rockets, supersonic aircraft, and the like. Literally millions of temperature controls, switches, breakers and indicators keep the American way of life functioning smoothly – and in most cases we hardly know of their existence because they operate without care of any kind for years. Even such simple instruments as the Marsh Thermometer require elements of precision fabrication and the ruggedness necessary to resist dropping and other accidental mistreatment. Chace's third of a century as manufacturers of precision bimetal *only* is one of the main reasons why Chace is specified by large and small buyers everywhere, whether their products be complex or simple.

While your new temperature actuated device is in the preliminary design stage, send for our booklet, "Successful Applications of Chace Thermostatic Bimetal." It's full of design engineering data with illustrated examples of uses of bimetal. Remember, too, that our precision product is available in strips, coils or completely fabricated elements of your design.

IT BENDS WITH THE HEAT

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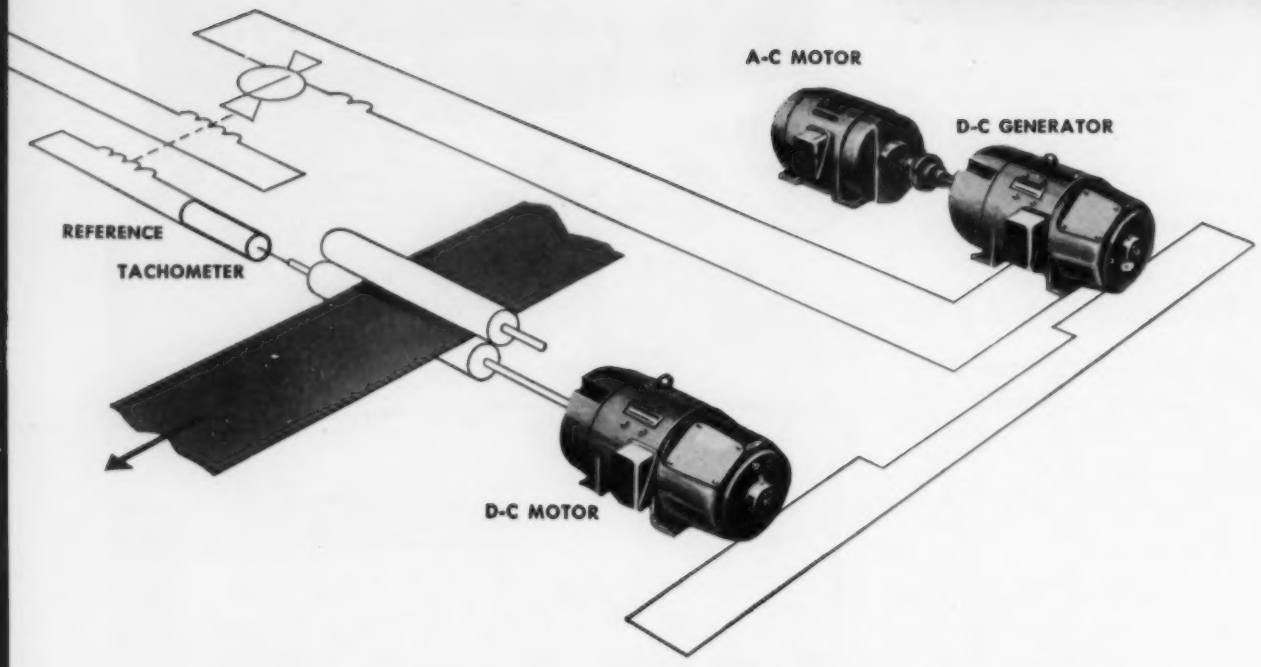
D-C DRIVES FOR PRECISE CONTROL



Problem: How to obtain precise control of machine speeds without human direction

Automation's most important requirement—*self-control*—enables machines to process work continuously with minimum human effort. This is why the trend to continuous automatic processing is a trend to direct-current drives. *For d-c can best supply the precise regulation and self-control that enables a machine to correct its own errors without human direction.*

Feedback—the heart of automation—compares machine output with pre-established standards. Deviations are corrected automatically, instantaneously. This is just one example of d-c's modern capabilities.

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WHAT THE EXPERTS TELL US ABOUT MECHANICAL RELIABILITY

Formerly the exclusive preserve of electronics engineers, reliability now has a specialist of its own. This specialist is, first and foremost, a mathematician, but his methods and advice are just as applicable to bearings, gears, rivets and pins as they are to vacuum tubes or capacitors.

RICHARD M KOFF senior associate editor

■ Most missile failures have been mechanical failures. Most maintenance, debugging, trouble-shooting, is mechanical in nature. Yet the most sophisticated reliability analyses are of electronic components and systems.

Electronic assemblies are made of many components, each with a limited life. This means you have to substitute probability for positivity (to coin a word). The trouble is that statistics and probability have a way of starting in the comfortable areas of here and now, but they soon bring in symbolic notations and high-flown logic that leaves us poor mortals gasping.

Reliability experts lost the respect of mechanical designers by making predictions like, "We can guarantee, with 95% assurance, that all the widgets will fail after between 200 and 1500 hours running time." This is useless because, for the requisite degree of prediction accuracy, the range of time is so broad as to be meaningless.

What *is* applicable to most mechanical design functions is the precise terminology, the definitions, the patterns of thought and even some of the simpler mathematical techniques used by the experts in this field.

What is reliability?

"Reliability is the probability that a device will perform, without failure, a specified function under given conditions for a specified period of time."

With minor modifications this is the accepted definition among reliability experts. It introduces a measure of uncertainty at the very first blush and makes it clear that 100% reliability is never really attainable.

To start, you have to know something about the failures likely to plague your gadget. There are generally three types of failure. Wear-out failure is associated with a slow loss of material (rusting is one example), or loss of efficiency. It is a progressive reduction of product capability. Somewhere along the line the component or accumulation of components degrades to the point where it cannot perform its specified function. This is wear-out failure and

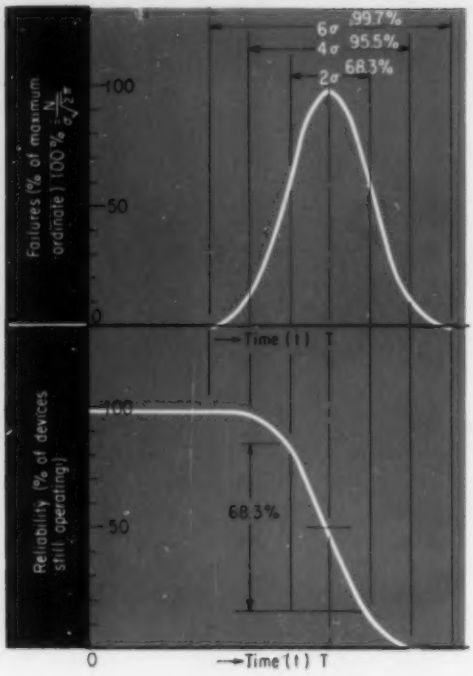


Fig 1—Wear-out failure.

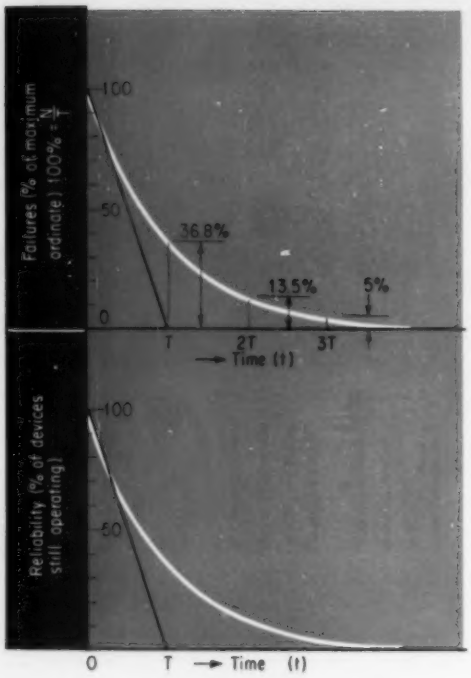


Fig 2—Constant-hazard-rate failure

requires careful definition of what will be considered "failure" by purchaser and manufacturer.

Wear-out failures tend to group themselves near some average time or number of cycles of operation. Most tires of a given kind will wear to the canvas in 25,000 miles (though they may be classed as unsafe—hence failures—long before that). Most men's shirts will withstand 50 launderings. After a number of life tests, wear-out failures are relatively easy to predict.

But, to confuse the picture a bit, we've also got failures with a constant hazard rate. This is a kind of "all other" category since it comprises all failures which are inherently unpredictable—hence equally likely at any time in the life of a product. You can't predict when that tire will run over a 4-inch spike. A chip of steel could fall into a gearbox and tear holes in the gear teeth. Hidden defects in a cast link may open a crack after, say, 2000 load cycles.

Such failures are assumed to be evenly distributed in time, and as the time of wear-out failure approaches there is strong overlap and interaction of the two types of failure. If all the cast links had the same defect you'd be convinced you had a wear-out failure at 2000 load cycles. The chip of steel in the gearbox might wedge in a bearing and accelerate bearing wear for a while, and then get washed away in the lubricant. You'd never know you had a constant-hazard-rate influence on a wear-out failure.

Infant mortality is a third type of failure. When a newly assembled device is first turned on many of the assembly mistakes or fabrication errors immediately reveal themselves. This "running-in time" has a failure rate that starts high but drops off quickly to the constant hazard rate mentioned above. Infant mortality should not plague the customer since the failures should have been eliminated before he ever sees the product.

The causes

So much for the types of failure. Reliability experts have categorized the causes too. You can have a failure of a component part—which stops the whole action. When a bearing seizes or a high-pressure line splits open, everything stops. Or a device may fail when several components have dropped low enough in efficiency to make the over-all function unsatisfactory. If a vacuum-cleaner filter begins to clog it reduces the suction somewhat, but that alone may not be enough to call itself to the attention of the housewife. If the motor bearings need oil and slow the speed of the fan, the cleaner might not lose enough suction to interfere with function. But the two together would make the cleaner useless.

Environmental factors are great abettors of all types of failure. High temperature and humidity may accelerate oxidation and wear. A heat wave may push a hydraulic system over the maximum design temperature. Both wear-out failures and constant-hazard rate failures are likely, and even predictable (on average), if the operating environment is known early enough in the game.

The cures

To extend product life the manufacturer starts thinking about reliability early in the design and continues right on through prototype, manufacture, inspection, shipping, installation and maintenance.

Off-the-shelf components have varying reliability; have you chosen the most suitable one in the light of the desired function and anticipated environment? Will all components of this kind be of the same quality?

Manufacture and inspection can destroy a careful design by carelessness. A too-tight seal, a too-loose nut, a dirty bearing, will make a "lemon" out of the best laid engineering plans. Current American automobiles are probably the worst offenders in this area, and simpler European models, with 100% inspection and pride of workmanship, woo many disgruntled customers away from our mass-produced, sloppily put-together engineering marvels.

Once the equipment is installed (hopefully, as originally planned) and operating in the anticipated environment, the constant-hazard-rate failures are out of your control. You can't prevent failure caused by a casting flaw or an over-stressed bolt. But you can prevent wear-out failures and this is the purpose of preventive maintenance.

Regular maintenance examination will turn up worn motor brushes, noisy bearings, clogged filters—and replacement can be made before failure. Of course, maintenance can be carried too far. High reliability at the expense of interminable maintenence is not high reliability at all.

The math

Let's take a quick look at some of the more elementary statistical concepts in reliability. For example, wear-out failures tend to take a normal probability distribution about a mean life time (Fig 1). The exact curve shape and location are described by two parameters: σ the standard deviation, and T, the mean time to failure.

The standard deviation of a given failure distribution tells how widely spread the failures are likely to be in time. With T large, relative to σ, one standard deviation away from T falls on the inflection point of the curve (when the curvature changes from concave to convex). Of all failures, 68.3% will occur between the two inflection points ($T \pm \sigma$); 95.5% will fall between two standard deviations over and two standard deviations under the mean time ($T \pm 2\sigma$); and 99.7% will fall between three standard deviations over and three standard deviations under the mean time ($T \pm 3\sigma$). Just for the record, you calculate standard deviation

$$\sigma = \sqrt{\frac{\Sigma\,(T - t)^2}{N}}$$

where T is the arithmetic mean, t is the time of any particular failure, N is the total number of failures and σ is the standard deviation.

The equation for the Gaussian distribution is

$$y = \frac{1}{\sigma\sqrt{2\pi}} \exp - \frac{(T - t)^2}{2\sigma^2}$$

but if you have to plot one you're better off checking any good book of tabled mathematical functions.

The consequence of this type of failure is a reliability function which is one minus the integral of the failure distribution. This plots as the percent of devices still operating at any particular time.

Constant-hazard-rate failures are equally likely to occur at any time during the life of a product. Suppose you've reduced this type of failure to a minimum of 10 per 100 operating devices every 100 hours. Starting off with 100 devices you lose 10 in the first 100 hours, 9 in the second 100 hours, a little over 8 (8.1) in the third 100 hours, etc. This plots as an exponential curve (Fig 2).

$$y = \frac{1}{T} e^{-\frac{t}{T}}$$

where T is the mean time to failure, y is the number of failures occurring at time t. Again, the reliability function is one minus the integral of the failure distribution

$$R = e^{-\frac{t}{T}}$$

In all these formulas you multiply y or R by the number of devices in your sample (N) to get numbers specifically applicable to the problem at hand. However, in this general form we're better off dealing in percentages because several such curves—each applying to a single component—will be combined in the reliability analysis of a complete product.

Combination effects

Suppose a product is made up of several components with differing failure characteristics. The probability distribution of wear-out failures will be different for each type of failure. There will be constant-hazard-rate failures, but again, each type has its own time characteristic. How do you combine them to find an over-all reliability function, and how do you account for interaction effects?

The reliability of a system is equal to the product of the separate reliabilities of its components.

$$R = R_1 \times R_2 \times R_3 \times \ldots$$

To find the system reliability curve, pick off the reliability of each component at a particular time, multiply them, and plot the product for that time on the new graph. Note that if there are several identical components in a single system, any one of which may cause a failure, you must include each as a separate item in the computation of system reliability.

Here's a sample of this calculation. The mechanical aspects of an electric motor are under examination in the hope of offering a 500-hr guarantee to customers. The motor has two brushes, two ballbearings and a small fan on the shaft to draw outside air around the field coils.

An analysis of electric failures (insulation breakdown, overload, burn-out) is known to be of the constant-hazard type, for all practical purposes, with a mean time to failure (T_1) of 20,000 hours.

The brushes have a sharply peaked wear-out failure characteristic centering on 1000 hours and with a standard deviation of 200 hours.

The bearings have a more broadly spread wear-out failure characteristic, centering on 1800 hours with a standard deviation of 600 hours.

Unpredictable mechanical failures—abrasive dust on the commutators or in the bearings—have established a mean time to failure (T_4) of 10,000 hours.

Note that both mechanical and electrical unpredictable failures have very long mean times relative to the wear-out failures, but because of their even distribution in time an

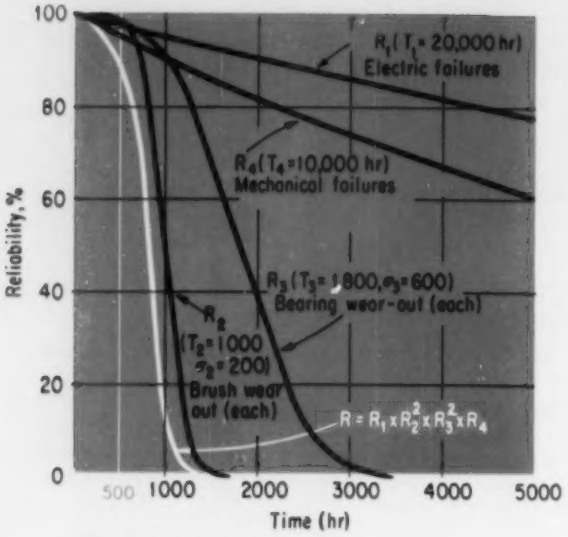


Fig 3—Electric-motor reliability analysis

annoyingly large number will fail before wear-out failures take over.

The most pertinent question is: What percentage of motors will still be running at the end of 500 hours? The answer is simple to calculate as a product of the component reliabilities at that time (see Fig 3).

Electric failures will leave 97.5% operating.

Unpredictable mechanical failures will leave 95.0%.

Each brush has a reliability of 99.4%.

Each bearing has a reliability of 98.5%.

The last two figures were derived from normal curve area tables available in most statistics reference books.

The total motor reliability is thus:

$$R = 0.975 \times 0.950 \times 0.994^2 \times 0.985^2$$
$$R = 0.887$$

This is hardly a very happy figure. The manufacturer would not be anxious to guarantee to repair 11 out of every 100 motors sold. But there's no difficulty finding where the problems lie.

The wear-out failures of bearings and brushes account for a combined reliability of 95.9%. This is a reasonable figure, and a small improvement in the bearing life (a new grease? a better surface finish?) might well raise the wear-out reliability to over 98%.

The unpredictable electric and mechanical failures cause more serious trouble. The mechanical engineer can point to the electrical problems (causing a reduction to 97.5%) but his own 95% contribution is nothing to be proud of.

Suppose the bearings were shielded to keep the grease in and the dust out. This might increase wear-out life to 2500 hours mean time (with the same σ of 600 hours) and simultaneously double the mean time of unpredictable failures from 10,000 to 20,000 hours (Fig 4).

Then each bearing would have a wear-out reliability of 99.9% at 500 hours and constant-hazard mechanical failures would have a reliability of 97.5%.

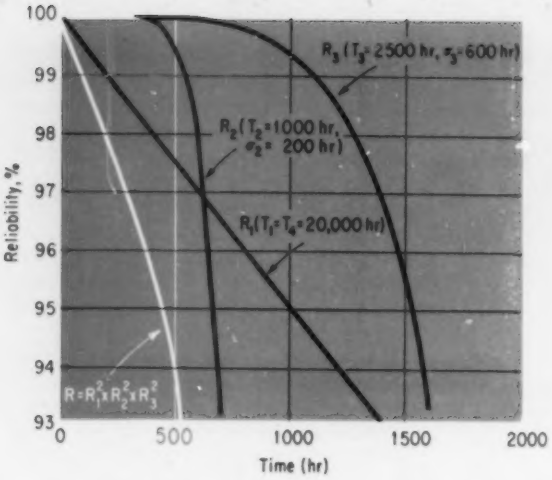


Fig 4—Motor with improved bearings

$$R = 0.975 \times 0.975 \times 0.994^2 \times 0.999^2$$
$$R = 0.936$$

This is a very substantial improvement. But perhaps the manufacturer is unwilling to take on more than one repair job in 20—a reliability requirement of 95%. What lifetime could he guarantee?

For this a full life time plot would have to be made as shown—the answer is 440 hours.

The challenge to mechanical designers

This example barely scratches the surface of what has become a substantial body of technical literature. Reliability is at the heart of environmental analysis and test, quality control, screening and sampling procedures, production control, value analysis, specification writing, and failure analysis. Government agencies now write their specifications in reliability terms—and delivered products must be proved out by standardized acceptance procedures.

As the number of working components in a system increases—and they must increase with the greater emphasis on automaticity and versatility—the reliability of each individual component must go up.

Further, environmental stresses are sure to get worse. Higher temperatures, higher pressures, higher speeds and accelerations are a fixed feature of each year's new model. Even 5 or 10% increase in environmental stress may halve the reliability of the component which must be "beefed up" by a far greater percentage than the increased stress may seem to warrant.

Until recently electronic components were the worst offenders. Vacuum tubes, relays, and capacitors burned out, shorted, jammed or arced-over long before bearings, gears, valves, or structural members failed. Today careful manufacture and the advent of solid-state physics have taken the worst offenders out of the systems and the mechanical designer is the butt of all the bad publicity.

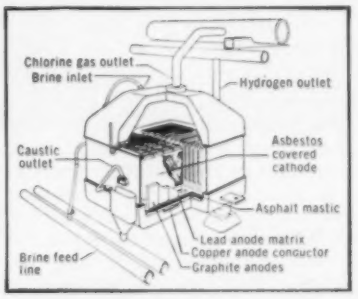
We must either produce better, and simpler, designs or let the electronics boys take over.

For REPRINT of above article, just check P21 on one of the Reader Service cards bound in this issue.

the LEAD newsletter

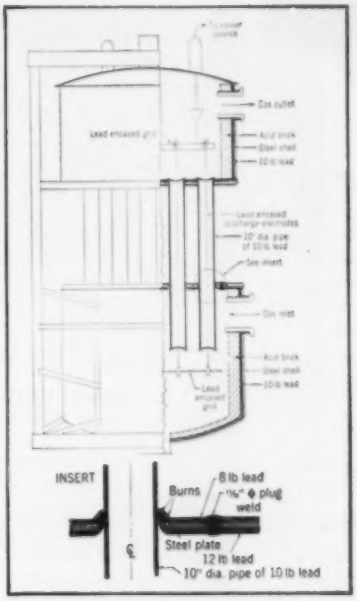
Lead The Safest Shielding in Portable Atomic Reactor

Engineers of Atomics International, a division of North American Aviation, Inc., have taken advantage of the unusual properties of lead as a reflector shield in a small "shippable" 5-watt research reactor. Designed for schools or medical and industrial laboratories, the reactor features a 6-in. thick lead neutron reflector-primary shield weighing approximately 3,800 lbs. This shield surrounds the core vessel containing aqueous uranyl sulphate, an homogeneous fuel suspension. It is purportedly the first reactor to employ lead as the only reflector material. Especially where mobility is important, lead for shielding purposes offers the best overall combination of design properties.



Conductivity Important In Hooker Electrolytic Cells

Practically all of the caustic soda and chlorine manufactured in the United States is made by the electrolysis of sodium chloride brine. Hooker Chemical Corp., which developed the cells shown here, produces over 35% of the nation's supply. The bottom section of the Hooker cell contains graphite blades cast in a lead matrix; lead is used as a coupling between the graphite blades and copper conductors of the cell's anode section. Chemical lead, containing less than 1% antimony, gives such excellent conductivity that the voltage drop at high amperages results in very nominal losses. Quality is important too, in obtaining the necessary dimensional stability and an efficient graphite-lead joint. Most of the 2,500 lbs. of lead used in each cell is recovered by melting the matrix in a furnace.



Lead Protects Electrostatic Precipitators Against Sulphuric Acid Attack

These electrostatic precipitators for Stauffer Chemical Company produce fresh, clean, strong sulphuric acid from refinery sludges and spent acids. As does most equipment of this type, these precipitators rely on the excellent resistance of lead to sulphuric acid attack to protect their structural components. In fact, the interior is completely protected by lead with the exception of the roof of the upper chamber, which is rubber lined.

Lead Proves Effective Protection From Gamma Radiation

Cities Service technicians are protected by lead while investigating the effect of radiation induced ionization reactions on petrochemical processes and products. Experiments are conducted while technicians are protected by 42 in. of leaded glass weighing 7,500 lbs. Nearby, a 12 in. thick lead door encloses 3 lbs. of Cobalt 60, which was transported to the site in a 6,000 lb. lead cask. This is only one example of lead's widespread use in isotope shipment, receipt, handling, and utilization throughout the country.

Lead Shield In Naval Nuclear Reactor

Over 20 tons of lead are included in the shield of the "Modified Swimming Pool" research reactor at the Naval Research Laboratory in Washington, D. C. The reactor, used for investigations in the physical sciences, provides an intense source of neutrons and gamma rays. It was placed in the pool to allow scientists to study radiation shielding problems of nuclear reactors for ship propulsion and electric power generation. Lead – widely considered in the field of nuclear energy as one of the basic shielding materials – is used here to absorb much of the gamma radiation from the core.

Many Uses For Lead

In addition to its use in reactors and portable radiographic equipment where compactness is desired, lead is widely used in atomic laboratories . . . in hospitals . . . and wherever there is a necessity for shielding against gamma rays. This is only one facet of lead's versatility. Leaded glazes put the gleam on wall tile, building bricks and fine china . . . lead paints guard against marine and atmospheric corrosion . . . and even help imitate mother-of-pearl.

If you have a new product or a problem that lead in its many forms may be able to help you solve, please write for the free advice of our scientists. Write to: *Office of Technical Information, Lead Industries Association, 60 East 42nd Street, New York 17, N.Y.* 1974

LOOK AHEAD WITH LEAD

CIRCLE 31 ON READER SERVICE CARD

TRENDS IN APPEARANCE DESIGN . . .

what shapes

DONALD L McFARLAND* and JOHN KOLB, Associate Editor

■ Normal influences that affect product shape—functional, manufacturing and marketing—are also present in the design of aircraft. Because the life-and-death relationship of this product to the medium in which it performs demands the most thorough integration and discipline, it is perhaps paradoxical that aircraft are widely accorded recognition as among the most beautiful of man-made products.

Why is this so? We asked engineers and designers (see listing at end) of some of the best-known American and European aircraft to tell us, to give us something of their philosophical, aesthetic and technological convictions. Said Pierre Satre: "The aircraft, like any other efficient tool or machine, gives us aesthetic satisfaction when we look at it only if it creates the sensation of suitability for its function. Hydrodynamic forms such as hulls and floats; aerodynamic ones such as wings, fuselages and empennages, tend to be naturally pure and beautiful. Their suitability is proved by wind-tunnel tests."

More than one answer

Yet there is sometimes more than one possible aerodynamic answer for a particular set of operating conditions. Our discussers agreed that there is much greater latitude in what is functionally permissible than is generally supposed—compare airplanes designed by different engineering groups for the same job. The P47 and P51 of World War II are a classic example. Or the remark of one chief engineer: "A freighter with wing struts would be eminently practical and reduce wing-root problems; but who would buy a plane with such struts today?"

But there isn't always agreement either. Another engineer insists struts would cost more in fuel than they would save in structural weight, because of the drag they would develop.

Today, jet passenger planes for roughly the same type of pay loads may have their engines in pods slung beneath the wing (as in the Douglas DC-8 and Boeing 707), buried in the wing (the British Comet and the USSR's TU104) or mounted on the fuselage back near the tail surfaces (the French Caravelle and the Lockheed Jetstar). The engineers and designers favoring wing pods mentioned easier maintenance, minimizing of noise and vibration, improved balance, reduced fire hazard. Fairing engines into the wing roots is frequently the best answer aerodynamically—as well as aesthetically. The rear-fuselage location is favored for mechanical, engineering, aerodynamic and handling reasons.

What shape fuselage?

Perhaps the structural basis that most influences our reactions to aircraft appearance is the fuselage configuration. The variable-diameter fuselage, which tapers from nose to tail, is probably preferable construction and provides the most graceful silhouette. The Lockheed Constellation has such a fuselage. However, this shape poses interior problems, particularly in seating arrangements. It is also the most expensive to manufacture and makes pressurization more difficult. Widespread adoption of the constant-diameter fuselage is a good indication of how optimum aerodynamics and appearance must sometimes be compromised to achieve the best engineering, manufacturing and operational characteristics.

And compromise most assuredly plays a major role in aircraft design, just as it does in other products. Sometimes the "integration" mentioned previously is nothing more than high-class compromise. A. B. Barnhart puts it differently, "An aircraft design is a vast collection of compromises which have been skillfully combined into a homogeneous whole."

Such compromises take one form which will be familiar to designers of a number of other products, particularly ships and heavy industrial machinery. In the aircraft industry it is known as "stretch-out", and is used for essentially the same purposes as elsewhere—a less-expensive way of engineering greater capacity or versatility into a machine originally developed for another set of operational requirements. Sometimes stretch-out is applied to an aircraft solely because new developments in power plants make it possible to attain greater passenger loads by simply enlarging an established airframe.

The fat and the lean

Then there is the fact that only actual flight service can finally prove where a given design's fat and lean parts are. Changes in structural provisions according to proved stress loads and their effects can then be made. Also, a new craft may have potential abilities for which no market exists. As the market develops, the basic airframe can then be adapted. While there may have been instances in which a plane's design was stretched out because of poor engineering planning or lack of genuinely new ideas or developments, advanced aerodynamic design is almost always ahead of available development funds and time. "Make no mistake about it," says George Perkins, "airplane manufacturers would be delighted to sell a brand-new airplane every time if there was an adequate market for it!"

Who designs aircraft?

What kind of people influence the shape of aircraft? Paul J. Petlewski believes that "This field of design has an inherent appeal for those individuals having a feel for the aesthetic as well as the functional values." A plane's appearance is generally set early in the design stage, largely by engineers and similar personnel with scant background in visual design. While industrial designers are retained by the major manufacturers, their contribu-

* Chairman, Board of Directors, American Society of Industrial Designers; B S Ae E; manager, Industrial Design Operation, Housewares Div, General Electric Co.

De Havilland Comet

aircraft?

Lockheed Jetstar

Douglas DC-8

An example of stretch-out. From top, the Douglas DC-4, DC-6, DC-7

Armstrong-Whitworth Argosy

Handley Page Victor

Republic P 47

Bell P 51

Sikorsky helicopter

Alouette helicopter

tions are generally limited to interiors. "Our function," says industrial designer Frank Del Giudice, "is to incorporate all the physical elements of the plane's interior into designs that will comprise a satisfying environment."

The future air traveler may see changes in these interiors. Consensus is that the supersonic speeds just ahead of present-day aircraft capabilities are likely to be skipped with the development of hypersonic planes, flying at two and three times the speed of sound. With such vastly greater speeds, passengers will spend much less time aboard, consequently interior arrangements and service equipment may see considerable change. Some designers believe the variable-diameter fuselage may well be brought back into widespread use by the need for longer nose and tail tapers. Others think such high speeds will dictate even stronger adherence to conical and cylindrical fuselage sections. The "coke-bottle" configuration of present-day Mach I fighters is likely to lose out to the finer length-to-diameter ratios required by hypersonic speeds, so that applications of the area rule will be less and less noticeable.

The growing interest of aircraft designers and manufacturers in the rear-fuselage position for power plants is likely to bring in its wake new configurations aimed at integrating the engines more completely into this new basic arrangement.

The helicopter and the VTOL

A number of the engineers and designers interrogated mentioned the helicopter as an example of one of the last strong points of resistance to appearance improvement—and even that is beginning to fall. Charles Marchetti points out that the best of the newer machines are beginning to look like the air-borne tools most of them are intended to be, and less like the operating mockups they have resembled until now. Even this is likely to prove transitory, because as A. R. Lambert says, "Some of the vertical-takeoff machines already have very definite aesthetic appeal. Much will be accomplished in this area."

Helicopters and VTOL craft are probably among the most extreme examples of the effects of assigned tasks on an aircraft's looks. In general, these products have tended, primarily for functional reasons, to look the part they play. Fighters customarily look fast, rugged and stable. A cargo transport, with its characteristic twin-booms and total-access fuselage, looks like the work horse that it is. The passenger transport must not only appear in the form of rapid transport that it is, but must also assure the passenger-viewer that it is safe.

In the good old days, according to one British aircraft engineer, the designer was fairly free to draw his concept of the plane-to-be with a soft pencil—and the ship was often largely made from such an initial drawing. Today, with speeds of over 600 mph, aesthetics can only be based on long, patient engineering work, based on aerodynamic findings developed in such massive test facilities as highly instrumented wind tunnels.

Tradition and desire

Yet the limits within which such high-performance equipment may reflect appearance considerations are wider than might be expected. Besides, today's aircraft designer has even more traditions—and at least as much desire—to produce the most aesthetic treatment within given operational and technical specifications. Thus, if a present-day aircraft is good-looking, it is probably because this characteristic grows naturally out of the factors making up the entire design project.

Still another consideration is the rate of change and development in aircraft design, perhaps one of the most rapid and revolutionary. There is always the danger of judging a plane's looks by preconceived notions of beauty, as Lucien Servanty points out, which may have been outmoded by the advent of the new plane itself. And there is always the question of who is doing the looking. "Swept-wing aircraft are now generally conceded to look good by the general public, but they are good only over a specified flight span," comments I. Nevin Palley. He goes on to say, "What looks good must be firmly based on technical and scientific facts if it is to be *really* good."

This is substantiated, according to G. A. Lachmann, by the belief, back in the early days of aeronautical history, that the best-looking planes were birdlike in appearance. The famous Etrich Rumpler Taube, circa 1911, was a favorite at that time, having pinioned wings with trailing edges scalloped like its feathered colleagues. Lachmann believes that "People now think more functionally."

Who buys appearance?

One thing is sure: Pleasing appearance does help to sell aircraft. Private and corporate buyers do not hesitate to admit it. Airlines always emphasize how thoroughly they provide for safety, convenience and dependability in the equipment they buy, but they also stress the good looks of their fleets in virtually all their advertising! The military is also strongly influenced, although they seldom admit it and also buy, sometimes too readily, the latest in aerodynamic fads and gadgetry. As Lachmann says, "You find no ugly ducklings among successful commercial aircraft, but there are plenty of unappealing military planes."

D. E. Burleigh sums it up, "Designers are becoming more conscious every day of the need of aesthetic values in the shape of the aircraft they work on. More time is being spent in the mock-up stage than ever before." ■

Whatever value this article may have stems largely from the generosity and imagination with which our contributors gave of their wealth of engineering and design experience. To these men, among them some of the creators of the world's most famous aircraft, the authors' thanks.

J B ALLYN, director—market development and service, Chance Vought Aircraft, Inc
HERMAN BARNETT, chief project engineer, Beech Aircraft Corp
A BAKER BARNHART, partner, Raymond Loewy Associates
D E BURLEIGH, manager—engineering administration, Beech Aircraft Corp
FRANK DEL GIUDICE, partner, Walter Dorwin Teague Associates
A R LAMBERT, chief—preliminary design, Convair, Div General Dynamics Corp
I NEVIN PALLEY, senior vice president, Temco Aircraft Corp
GEORGE PERKINS, associate, Henry Dreyfuss
PAUL J PETLEWSKI, associate, Harley Earl Associates

. . . and from abroad—

G A LACHMAN, director of research, Handley Page Ltd, England
CHARLES MARCHETTI, director—dept of helicopters
PIERRE SATRE, chief project engineer
LUCIEN SERVANTY, director—etudes avions
Societe Nationale de Constructions Aeronautiques du Sud-est de France

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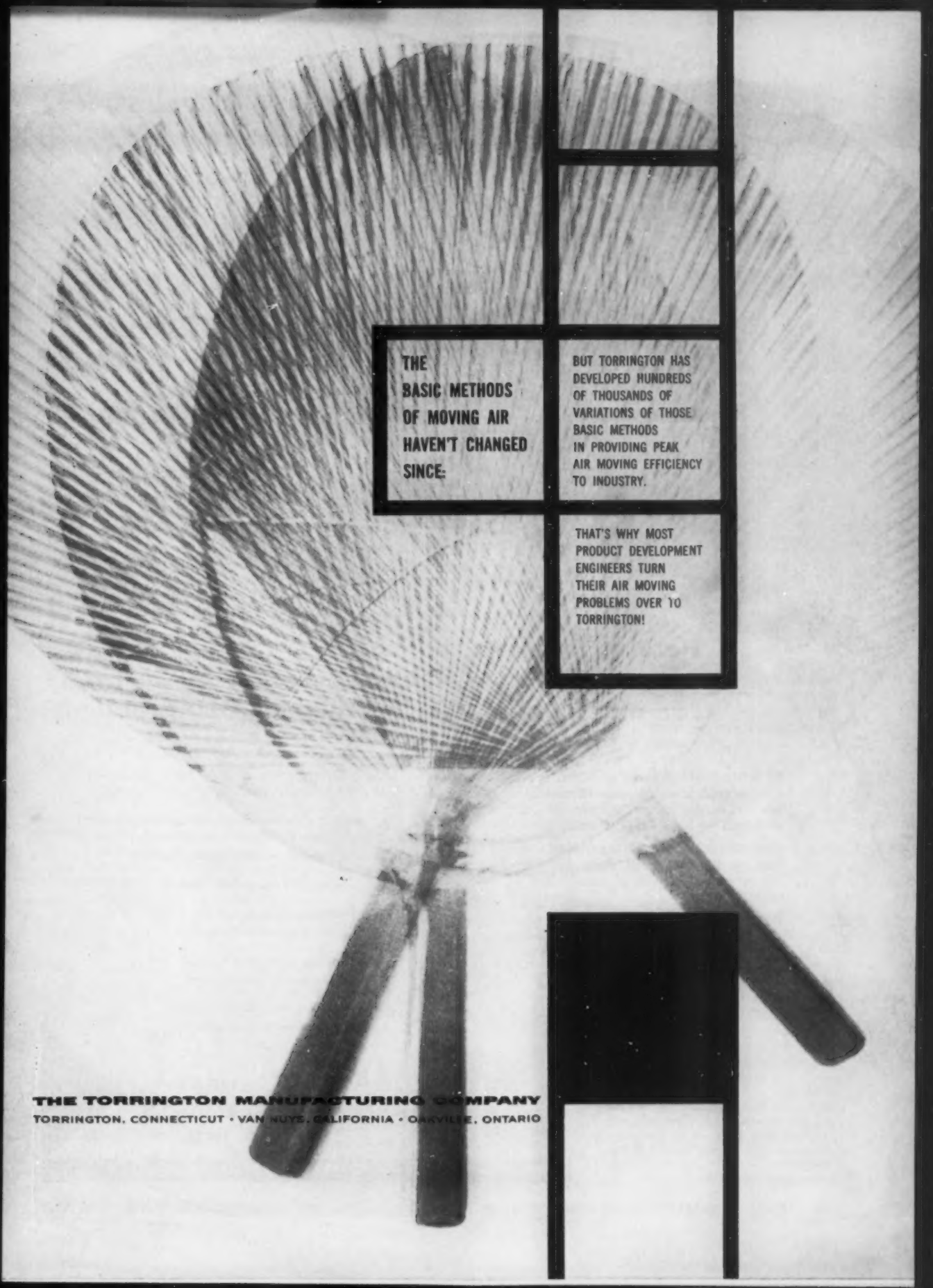
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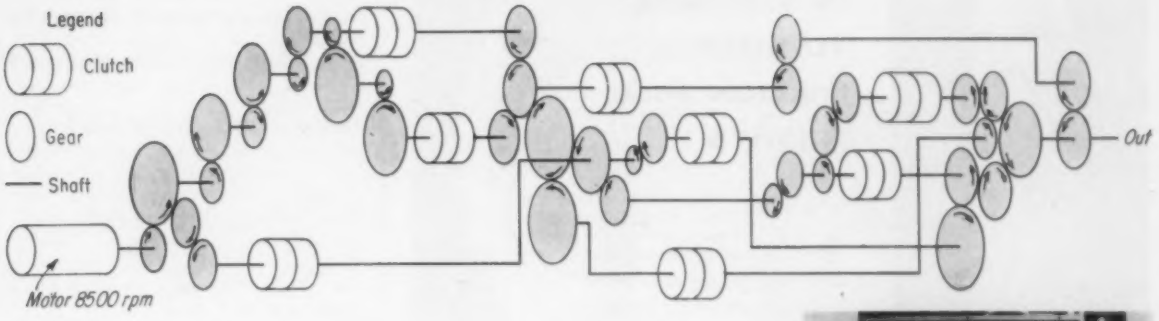

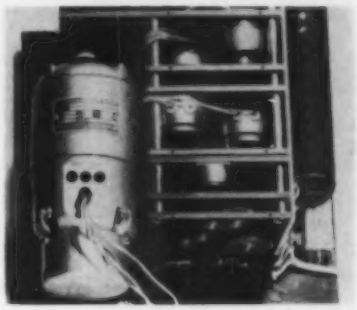

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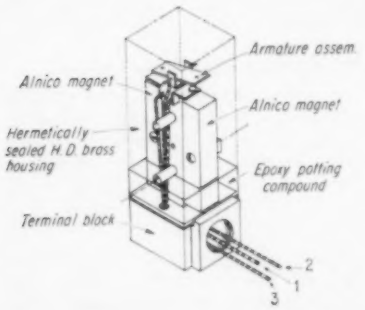
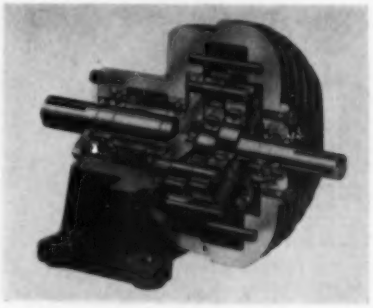


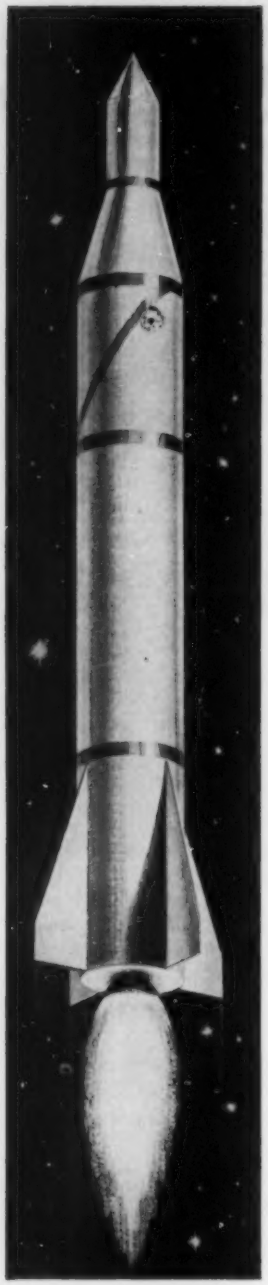


Cycloid reduction drives . . .
are said to be 40 to 60% smaller than other types of speed reducers with comparable ratings and to provide wider torque range. Produce torque of from about 30 in.-lb per lb of reducer weight to over 80 in.-lb per lb. Offer wide selection of ratios. Drives run, almost noiselessly, in oil-sealed cast-iron housing, with multiple-tooth distribution of load at all times. Units, which vary in size from instrument drives to those for large machine tools, are said to lend themselves to integral design. **Black Tool Inc, 1924 S Navajo St, Denver 23.**

Circle 103 on Reader Service Card

Variable-area flowmeters . . .
consist of flow transducer and flow indicator. Transducer measures volumetric rate of flow of fluid and converts it to electrical signal. Flow indicator furnishes electrical excitation to flow transducer and converts flow transducer output signal to meter indication. Low-impedance dc voltage, which can be used to drive graphic recording instrument, is available from pair of front-panel terminals. Flowmeters have usable range of about 50:1; frequency responses to 50 cps. Electrical power required is 115 v, 60 cps. May be mounted in any position. Said to be accurate to 2% of full scale. Available in five models with full-scale flows of 0.13 to 10 gpm. Low-flow units are particularly useful in measurement of leakage and controlled

(CONTINUED ON PAGE 38)



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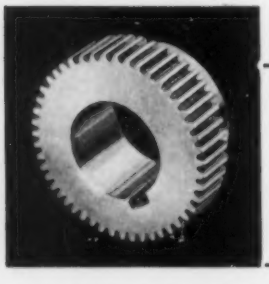

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SIGNIFICANT COMPONENTS MATERIALS PROCESSES . . .

(CONTINUED FROM PAGE 37)

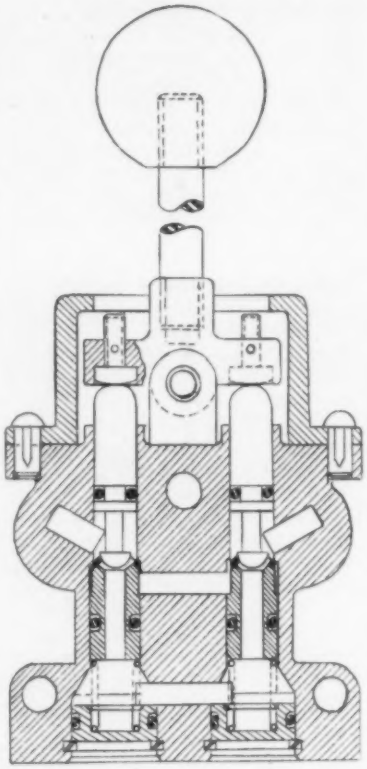
flow in hydraulic servo valves, leakage flow in missile hydraulic systems and similar applications. **American Measurement & Control Inc, 240 Calvary St, Waltham 54, Mass.**

Circle 104 on Reader Service Card

Heavy-duty terminal blocks . . .

has two pressure-contact set-screws and thick, cross-section copper-bronze contact members at each terminal position. One-piece blocks are molded of plastic. Available in 2 to 12 terminal lengths. Rated at 85 amp min and above 8000 v breakdown test. **Kulka Electric Corp, 633-643 S Fulton Ave, Mt Vernon, NY.**

Circle 105 on Reader Service Card



Miniature full-flow valve . . .

can be used interchangeably in pneumatic, hydraulic or vacuum service. Said to be capable of performing same work as current valves five times its size and weight. Offered in four ratings: 0 to 20, 20 to 500, 500 to 1000 and 100 to 1500 psi. $\frac{1}{8}$-in. body unit, with $\frac{1}{8}$ and $\frac{1}{4}$ in. ports, with 100-psi differential pressure, achieves 2 gpm full flow through $\frac{1}{8}$ in. orifice. Now available for about 2-wk delivery. $\frac{3}{8}$ and

½ in. units will be ready after Jan 1 '60. Three and four-way models are priced about $17 and $22 for manual control valves; $28 and $33 for single-solenoid units; $41 and $46 for double-solenoid types, respectively. **Gabriel Co, 1148 Euclid Ave, Cleveland 15.**

Circle 106 on Reader Service Card

Mechanically-locked filter . . . elements are produced by high-pressure process that locks components (including media, end caps and center tube) so that filter medium is embedded in parent metal of end caps, forming leakproof seal. Since no welding, brazing or bonding agents are required in construction, filter element is free of built-in contamination, is lighter because weight-saving dissimiliar metals can be used for components. Presently produced with stainless steel wire mesh media elements of 1 to 1¾ in. dia. Temperature range has been increased from normal 500 to 600 F to 1000 F, limited by housing components. Withstands collapse pressures of more than 4500 psi and meets vibration and impulse requirements of military specifications. Present ratings are for nominal 10 and 5 micron elements in ½, 3, 6 and 12 gpm capacities. For all types of filtration, including oil, fuel or pneumatic systems. **Purolator Products Inc, Dept 108, Rahway, NJ.**

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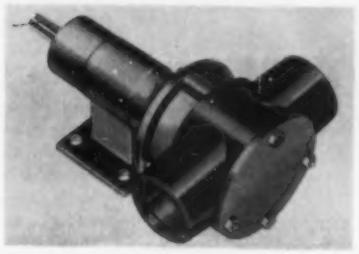

Self-priming pump . . . for general transfer applications, has 27.5 gpm capacity against 10-ft head, suitable for use up to 25 psi with dry vertical suction lift approaching 15 ft. Phenolic plastic body; 1 in. inlet and outlet ports accommodate standard 1 in. pipe fittings. Measures 10 x 4¾ x 4½ in.; weighs about 9 lb. **Jabsco Pump Co, 1485 Dale Way, Costa Mesa, Calif.**

Circle 108 on Reader Service Card

Solenoid drive attachment . . . for use with rotary switches in conventional stepping arrangements or master-slave operations, incorporates feature that allows manual operation in event of power failure. Rotary unit, available from stock, has standard range of 10 to 200 amp. **American Solenoid Co, 150 Madison Ave, Union, NJ.**

Circle 109 on Reader Service Card

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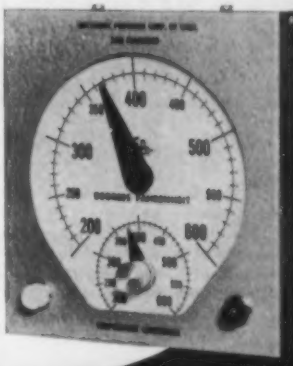

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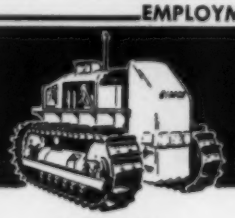

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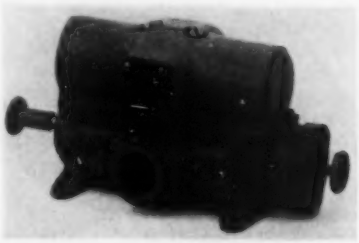
Synthetic rubber latex . . .

is said to be 20 to 30% below natural rubber in cost, yet to be comparable to it in performance. Butadiene-styrene (70/30) material (Pliolite 5352), a high solids product (68% min), is also reported to offer aging properties twice as good as those of natural rubber, combined with excellent process ability, exceptional resistance to heat and light discoloration, and outstanding flex life and compression set life. Exhibits excellent viscosity-temperature properties at 40 to 80 F. Goodyear is producing the material as a 100% replacement for natural latex in foam rubber products fabricated by the firm and is also marketing it domestically and abroad to other processors. **Goodyear Tire & Rubber Co, Akron 16.**

Circle 110 on Reader Service Card



Solenoid selector valve . . .

is four-way, three position unit, spring loaded to neutral. Meets military specifications for 3000 psi, 65 to 275 F hydraulic systems. Production units are available in −4, −6 and −8 line sizes, with forged aluminum bodies and hardened 440C stainless steel spools and sleeves. **Hydra-Power Corp, Pine Ct, New Rochelle, NY.**

Circle 111 on Reader Service Card

Miniature dc motor . . .

with continuous-duty ratings to 1/100 hp, can be wound for series, split-series, shunt or universal operation. 1⅛ in. dia, with length determined by stack length. Torque to 6 in.-oz can be obtained for intermittent duty. Units can include brake, gears, governors. Operates on 6 to 75 v dc and provides output speeds of 6000 to 13,000 rpm. **Globe Industries Inc, 1784 Stanley Ave, Dayton 4, Ohio.**

Circle 112 on Reader Service Card

Adjustable slip clutch . . .

with torque range of 0 to 100 in.-oz, provides overload protection in precision gear trains, computers, servo mechanisms and breadboard setups. Offers repeatable

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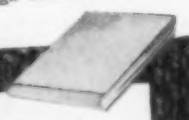

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breakaway torque. Concentricity is said to be to 0.0003 in. Reported to be corrosion-resistant and to have no backlash, chatter and galling. Measures 0.630 in. dia x 0.450 in. long. Weighs 0.03 lb. May be supplied with integral gear blank. Gear made to specifications. **Northern Union Inc, 1020 Holly Ave, Arcadia, Calif.**

Circle 113 on Reader Service Card

Reservoir filter elements . . .

for replacement use in cylinders, pumps, valves and other closely fitted parts in hydraulic systems are available in three sizes of four different filter media with micron rating from 2 to 100. All have 6 in. OD, with lengths of 2, 4 and 8 in. **Bendix Filter Div, Bendix Aviation Corp, 434 W 12 Mile Rd, Madison Heights, Mich.**

Circle 114 on Reader Service Card

Stainless shaft collars . . .

are precision bored with chamfers machined on inside and outside corners. 31 bore sizes available from stock range from ⅛ to 2⅛ in. dia in 1/16 in. increments. **Climax Metal Products Co, 863 E 140th St, Cleveland 10.**

Circle 115 on Reader Service Card

Wafer electromagnetic brake . . .

frame size 8, has over-all length of 0.405 in. and output torque of 16 in.-oz min at 24 v dc. Magnetic design is said to eliminate bearing thrust load and result in low drag torque of 0.05 in.-oz. max. Weighs 0.7 oz. Operates in −67 to 257 F. Power consumption is 2 w at 24 v dc. **Dynamic Instrument Corp, 59 New York Ave, Westbury, NY.**

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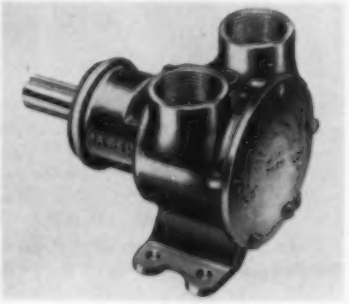
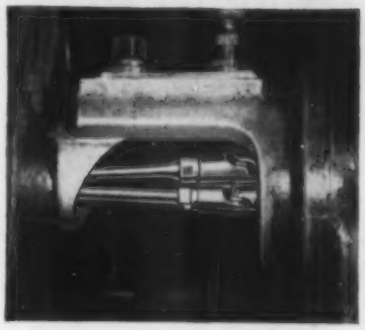


Footmounting bronze pump . . .

is for up to 2450 rpm operation, delivering 72.5 gpm against a 10 ft head. Self-priming at all speeds with vertical dry suction lift approaching 15 ft. Neoprene impeller. Has 1¼ in. vertical ports. 6 x 7¾ x 5 in.; 12¾ lb. **Jabsco Pump Co, 1485 Dale Way, Costa Mesa, Calif.**

Circle 117 on Reader Service Card

Solving a breakage problem AT CLOSE QUARTERS



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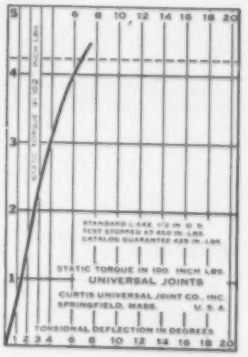
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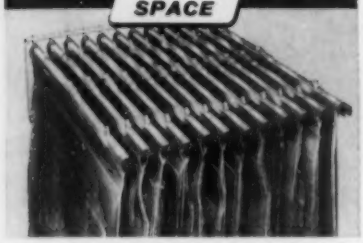

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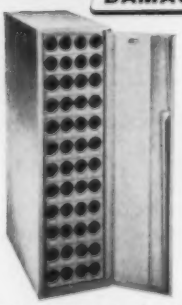

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CIRCLE 118 ON READER SERVICE CARD

Floor control stand . . .

consists of pedestal mount, 42 in. high, and any one of 11 sheet metal boxes for oil-tight pushbuttons. Pedestal has leveling screws in base. Pushbutton enclosure, which accommodates 1 to 25 oil-tight buttons, is 4¾ in. deep, with conventional hole arrangements. Pushbutton box inclined 30° from vertical. From stock. **Hoffman Engineering Corp, Anoka, Minn.**

CIRCLE 119 ON READER SERVICE CARD

Finger-tip wrench design . . .

enables user to reach into snug, narrow, remote or hidden working areas to touch and hold a nut or bolt in true fixed position for assembly or disassembly. Worn like a ring, wrenches are adjustable to fit different size fingers and are supplied in most popular hex head nut sizes. **Beaver Tool Co, Box 256, Huntington Sta, NY.**

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Switch-making kit . . .

contains 32 SPDT switches, representative of Class 2 and 4 switches that may be used to simulate a multitude of combinations and also to build multipole switches. All are UL-approved and rated 15 amp, ½ hp, 125 and 250 v ac. Eight varieties of

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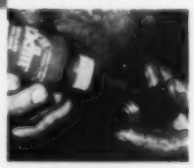

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actuator assemblies and 12 sets of assembly screws and nuts are included. Switches all feature patented basic mechanism in which bias and stresses producing snap action are inherent in one-piece beryllium copper blade. Fixed mounting of blade is midway between actuating and contact ends. **Detroit Controls Div, American Radiator & Standard Sanitary Corp, 5900 Trumbull Ave, Detroit 8.**

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High-contrast photoprints . . . are said to be produced by direct photoprint paper. No negatives needed. 0.003 in. thick, 100% rag content or vellum paper may be specified. Both may be processed in ordinary room light using standard photographic solutions. Makes wet-erasable prints ready for redrawing with pen or pencil. **Eugene Dietzgen Co, 2425 N Sheffield Ave, Chicago 14.**

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Drafting instrument . . . calculates and produces accurate arcs of radii from 4 to 240 ft. To draw a specific arc, appropriate master disk is fitted to end of instrument, telescopic scale is set at proper graduation and locked with finger screw. Disk is placed on radius line and weight-loaded pencil is positioned. Instrument is then rolled forward to produce arc of any length, including a complete circle. Can be used on most surfaces. Made with ball-bearing pencil holder. Supplied with set of five master disks in instrument case. Instrument, when fully extended, is 29 in. Weighs 1¾ lb. Made in England. Price is $75. Delivery, about 3 wk. **C F Carpenter Associates, PO Box 87, Allentown, Penna.**

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Assembly-time calculator . . . automatically estimates manufacturing time of electronic and electromechanical assemblies. Basic data fed into slide-rule calculator is type and number of operations comprising assembly. Can be used for estimating, scheduling, evaluating performances and setting objectives. Made of plastic. Provided with case and data entry sheets. $15 per unit. **Manufacturing Laboratories, 507 Fifth Ave, New York 17.**

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NEW LITERATURE

The Sport Car—Its Design & Performance

COLIN CAMPBELL. Robert Bentley Inc, 993 Massachusetts Ave, Cambridge 38, Mass. 6 x 9, 285 pp. $6.50.

The descriptions of solutions to the problems encountered when operating an auto under extreme conditions should be helpful to any automotive designer. Although written for those primarily interested in sports car design, the information included will be of interest to anyone involved in the design of engines, chassis or suspension systems.

The chapters devoted to the engine and its component parts discuss problems that exist in every engine but do not become evident until the engine is operated at its upper performance limits for long periods. Chapters on suspension systems, chassis, transmissions and brakes discuss design of the individual components and their effect on over-all performance. —JJK

Rocket Encyclopedia Illustrated

Edited by HERRICK AND BURGESS. Aero Publishers Inc, Los Angeles 26. 7½ x 10½, 607 pp. $12.50.

This is a big book—not so big as encyclopedias go; but rather big for its subject. Words and phrases are defined that hardly need defining and "explained" with explanations that often seem to need explanations themselves.

Each entry has, first, a "definition". Then an explanation. Atomic power, for instance, starts out like this:

"This term is commonly used for identifying the hypothetical atomic-energy-powered rocket propulsion units, the thermonuclear and the nuclear rocket power plants. Atomic rocket power plant is the vernacular term for any rocket propulsion system that is designed to use an atomic reaction for producing the primary thermal energy." Then comes the "explanation"—two columns of type, starting like this:

"It is understood that no operating model of an atomic rocket power plant has yet been fabricated or tested. The theory and calculations associated with this tremendous concept of power, however, have been of great interest to many qualified scientists and engineers. For promoting better understanding, the editors recommend that the particular types be correctly identified by the appropriate terms: (1) thermonuclear rocket power plant, for those arrangements that utilize nuclear fission reaction, and (2) nuclear rocket power plant, for those arrangements that utilize a nuclear fusion reaction."

All in all, a book for the encyclopedia-collector and for the library; but not a "must" for most engineers. —ARG

INDUSTRIAL FABRICS – Reference handbook, 32 pp. Gives properties, construction, applications and performance data of glass fabrics in industrial uses. United Merchants Industrial Fabrics, 1412 Broadway, New York 18.

Circle 140 on Reader Service Card

PRODUCTION TEST SERVICES, PRODUCTS–Brochure, 20 pp. Outlines engineering services and products for automatic measurements and control of processes by electronic and electro-mechanical techniques. Various equipment is shown. American Bosch Arma Corp, Chicago Div, 5857 W 95th St, Oak Lawn, Ill.

Circle 141 on Reader Service Card

COMPUTER BIBLIOGRAPHY–Booklet U-1806, 54 pp. Revised and updated edition of "Large Scale Digital Computers: An Annotated Bibliography." This 3rd publication of Univac Educational Series covers theory and operation, applications and general background and sources. Articles and books are noted for degree of technical complexity. Remington Rand Div, Sperry Rand Corp, 315 Park Ave S, New York 10.

Circle 142 on Reader Service Card

THERMISTORS AND VARISTORS–Technical catalog, 9th edition. Lists characteristics and specifications of about 600 stock thermistors, varistors, gas analysis cells, assemblies, and mounting accessories. Victory Engineering Corp, 546 Springfield Rd, Union, NJ.

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AEROSCIENCE PROJECTS AND FACILITIES–Booklet 59SD160, 20 pp. Summarizes activity in advanced aerodynamics, aerophysics, structures and dynamics, materials, research operations and applications engineering. General Electric Co, 3198 Chestnut St, Philadelphia 4.

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For Your Information (personal)

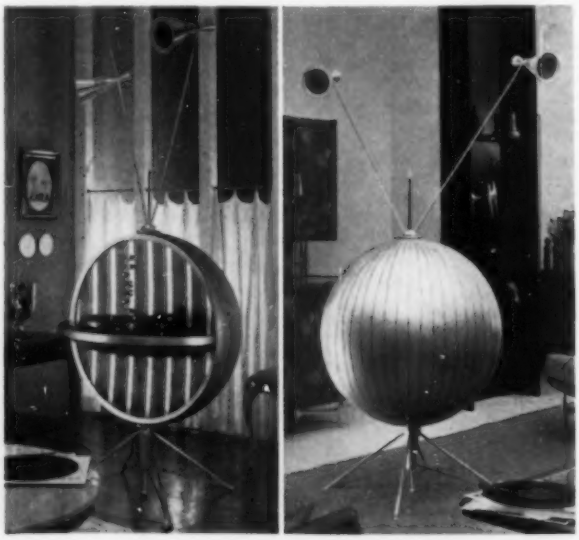
See-through boat

Latest thing in lightweight craft is this 44-pounder from Sudbury Laboratory, Sudbury, Mass. Most plastic boats are reinforced glass-fiber plastics; but this one is vacuum-formed from a sheet of Tenite cellulose acetate butyrate—just like the lightweight plastic packages that now surround everything from hardware to cosmetics.

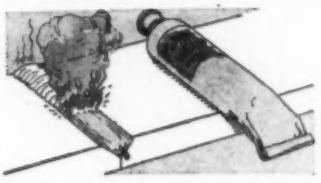
It will carry 600 lb, can be used with oars or a 3-hp outboard; and, says Eastman Chemical Products which supplies the plastic, its transparency has an added advantage: the boat may be placed on top of the cabin or over the skylight of a yacht without destroying its sleek appearance. The price: $199.95, plus packing and transportation.

Hi-Fi or Ovens, the sphere's the thing

Following close on the heels of its spherical oven-of-the-future, (*PE*—Mar 23, p 13), Alcoa has now come up with a stereophonic hi-fi set that looks like a balloon when closed, a ripe melon when opened. It's not in production—may never be—but represents another in the series of Alcoa-sponsored Forecast designs, aimed at stimulating interest in its light and shiny metal. Lester Beall designed it, claims it incorporates established audio engineering principles. Rabbit-ear speakers separate a good six feet to meet minimum stereo requirements, a downward-facing "woofer" bass speaker is provided in the main body; and the sphere itself is "an ideal source of sound reproduction." —ARG



Why Don't They R and D . . .



. . . a Thermit-like welding compound for small welding jobs or do-it-yourself projects. If mixed with a suitable vehicle, it could be given the consistency of toothpaste and marketed in tubes. Just squeeze a ribbon of this welding paste along the joint, insert igniter fuse and light. —R. Marie

. . . a trainer for automobile drivers that simulates highway problems in much the same way a Link trainer simulates problems for aircraft pilots. Competence of potential drivers is now examined and judged on the basis of performance during a short drive at low speeds around a few city blocks. But most serious accidents occur at high speeds on the open highway. Ten minutes in a driving simulator would help cull out the incompetent drivers and point up weaknesses in drivers who are otherwise reasonably capable. Simulator should include mockup of automobile interior, all instruments and controls. Projected image of road, seen through the windshield, could be made to move as controls were manipulated. Various problems presented to the driver—stop lights, oncoming cars, sharp turns, even treacherous road surfaces—would test ability to handle car under all normally encountered driving conditions. —F Buehler

. . . an outdoor paint incorporating an insect repellant to prevent gnats, flies, moths, mosquitoes from landing on freshly painted surfaces. During certain seasons of the year, a surface covered with fresh white paint can be turned gray in less than an hour by accumulation of small insects. Fast-drying paints, though less troublesome, do not set up fast enough to keep out insects on windy days. An insect-killing paint is on the market, but it is simply a protective (not decorative) coating. Perhaps an insect-chasing chemical could be similarly added to decorative paint. —U Ludwig

Have you a problem, based on known scientific principles, which seems to have an answer somewhere within the limits of present technology? To inspire inventors along worthwhile paths, PROJECT ENGINEERING invites you to trade such problems with fellow readers who may have a fresh viewpoint or more time for necessary R & D. We will pay $10 for each one accepted.

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Publisher's Postscript...

TEAMWORK takes a prize

I'm not talking about a world series game or a slam hand at bridge but about the combination of contributions from product engineer, industrial designer, mechanical and electrical engineer, controls engineer, materials and manufacturing groups and others, that goes to make a marketable product.

You'd think it would be easy. Customers' needs write a clear-cut set of specifications (if you can read them). The imagination and ability of designer mold theory into models and drawings. The ingenuity and know-how of manufacturing engineers bear hardware fruit. The result: a reliable, inexpensive, attractive, and marketable product.

Sounds simple, but how rarely this happens. The errors of judgment, misunderstanding of reports, misinterpretation of instructions or tests results or surveys, are continuing hazards, and even the team that produces a successful product today has no guarantee of producing another one next time. The odds are a little better maybe, but that's about all.

For some time we've been wondering about this. There is no substitute for experience, that's obvious. But at least part of what we learn must be from example. So we're looking for examples.

PRODUCT ENGINEERING is instituting the first of a series of Annual Awards for Achievement in Product Develepoment. The purpose, recognition for a job well done, plus the publication of the biography of a product-development program so that others may learn something from an award winner's experience.

Excellence of engineering and appearance, fulfillment of design and marketing objectives will, of course, weigh heavily in determining the recipient of these awards, but the degree and quality of integration between engineering, design, manufacturing and marketing personnel and resources will be equally important.

To be eligible for the first year's award a development program must have introduced a product for sale between March 1, 1959, and February 29, 1960. The product will probably incorporate metal or plastics and have required one or more processes of manufacture, such as machining, molding, extrusion, forming, assembly. The product may not contain its own power source, but it will almost certainly use or transmit energy in some form. It probably will include moving parts and their control.

Judges are to be drawn from several fields, engineering and engineering education, marketing and product-development organizations, industrial design, human factors engineering, manufacturing, distribution, and from the editorial staff of PRODUCT ENGINEERING. They will award as many citations as they feel are warranted, based on the excellence of the entries. There will be no rating of awards relative to each other.

If you would like an entry blank and more information just write "Awards" in the space marked Special Data on the Reader Service card on this page, add your name and address and send it in. –SJA

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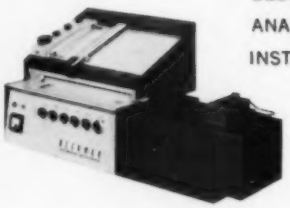

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